Assessment

Forest Plan Revision

Draft Nonforested Terrestrial Ecosystems Report

Prepared by:
Kim Reid
Rangeland Management Specialist

for:
Custer Gallatin National Forest

November 29, 2016

Contents

Tables

Figures

Introduction

Vegetation is complex and subject to an array of interacting ecosystem processes. The extent, type, and condition of vegetation is dependent upon relatively fixed site capability features on the landscape, such as soils, combined with the influences of system drivers such as climate, fire and herbivory disturbances, and human activities. This report addresses the terrestrial non-forest vegetation as described in Region 1 existing vegetation (2015) database (VMap). Non-forested vegetation *using this database* is defined as riparian vegetation, grasslands / shrublands, sparse vegetation, alpine and the rare tree types such as juniper, limber pine, aspen, cottonwood, and green ash woodlands.

Important to Note: This report will have some overlap with the Terrestrial Ecosystems – Forested Report relative to assessments on the rarer tree types of juniper, limber pine, aspen, cottonwood, paper birch, and green ash woodlands. The Terrestrial Ecosystems – Forested Report addresses these cover types overall. However, that report primarily uses forest inventory and analysis data which has limitations representing the amounts of these rarer cover types. Given the nature of the plot grid of forest inventory and analysis protocol, many of the minor cover types do not get enough data points for analysis use and Region 1 existing vegetation database data were used for these rare tree cover types and non-forested cover types to determine amounts and distribution.

Related but Separate Reports: Invasive plant species can alter the composition and diversity of riparian areas if left unmanaged. Although briefly addressed in this report, a separate Invasive Plant Species report can be referenced for detailed information on this topic.

Many tools and approaches are available to accomplish biodiversity conservation goals, from active management to designation of reserves. Research natural areas and special interest areas may provide long-term protection for biological elements of special concern, especially those with limited distributions such as rare plants and plant communities. Although briefly addressed in this report, a Research Natural Area / Special Interest Area Report can be referenced for detailed information on these topics.

Biological plant diversity is one of the cornerstones of a healthy ecosystem. When diversity is threatened or lacking, the ecosystem can lose balance. To mitigate potential loss of diversity, the Forest Service has listed species at risk (endangered, threatened, or candidate) to protect their viability and habitat. Although briefly addressed in this report, a separate “at risk” and potential “species of conservation concern” report can be referenced for detailed information on this topic.

Process, Methods and Existing Information Sources

In brief, the primary data sources used for this assessment include literature review of the best available science (see Literature Cited section), consultation with regional experts, partners, and the following:

Region 1 Existing Vegetation Database (VMap): Mapping of vegetation is based on the Region 1 vegetation database. It is a geospatial dataset developed using the Region 1 existing vegetation classification system (Barber et al. 2011). It is a remotely sensed product that is derived from satellite imagery, airborne acquired imagery, field sampling, and verification. Detailed metadata for this database can be found in the project file.

Riparian vegetation classifications in the original existing vegetation database do not include hydrological features; therefore, more refined riparian and wetland area data sources were incorporated using National Wetland Inventory data provided by the Montana State Natural Heritage Program which also covered the South Dakota portion of the Sioux District. National Wetland Inventory maps riparian and wetland areas based on aerial imagery, hydrological feature mapping, soils, and vegetation layers.

For the montane units, National Wetland Inventory map and the Montana State Natural Heritage Program data and riparian extent model were used for inclusion into the Region 1 existing vegetation database. Riparian extent was modeled by using a tool developed by Forest Service Washington Office personnel for the montane units. The model made use of a lakes/ponds feature class, digital elevation models, 6th hydrologic unit code watershed boundaries, and NetMap streams data and parameters are applicable to hydrologic considerations of the montane units as opposed to the Pine Savanna units. While the model will also accept hydric soils and hydrologic soil group information, the lack of these available data precluded their use in the mapping effort. Locations within the modeled riparian area that did not intersect with the Montana State Natural Heritage Program riparian polygons were attributed with Region 1 existing vegetation data via intersection. Where upland vegetation was mapped within the riparian corridor, a local classification was assigned denoting that while the location was not classified as containing riparian vegetation, it fell within the riparian corridor (Reid, et. al., 2016).

For the pine savanna units, National Wetland Inventory map data and refined Region 1 existing vegetation database green ash woodland data (Biswas, et. al., 2012) were used for inclusion into the Region 1 existing vegetation database. Flow regimes and stream orders were used to differentiate between non-riparian green ash woodlands and riparian-green ash woodlands. The riparian extent model used for the montane units was not used for the pine savanna units due to limited application of model parameters.

Forest Inventory and Analysis: Summarization of forest inventory and analysis. Forest inventory and analysis draws upon measurements collected on spatially balanced forest inventory and analysis grid plots. The forest inventory and analysis grid is a nationwide grid which includes 517 plots on the Custer Gallatin National Forest. This dataset is used to display estimates for the plan area because it spatially represents all National Forest System lands. Given the nature of the plot grid, many of the minor cover types do not get enough data points for analysis use and Region 1 existing vegetation data was used for amounts and distribution of rarer tree cover types and non-forested vegetation cover types.

Ocular Macroplots: Summarization of ocular macroplot inventory and analysis of ground cover data (Natural Resource Management Natural Resource Information System database).

Potential Vegetation Mapping (Jones PVT 2005): This Region 1 layer was developed to map groups of potential vegetation types (based on habitat types), and incorporated into the Custer Gallatin National Forest vegetation layer (Region 1 existing vegetation database). The assessment utilizes an initial calibration of this layer which included adjustments to resolve illogical combinations with Region 1 existing vegetation database attributes. Additional calibrations are ongoing and will be included in additional modeling associated with Forest Plan revision.

Proper Functioning Condition data - Riparian: Proper functioning condition is a methodology for assessing the physical functioning conditions of riparian areas. It defines a minimum level or starting point for assessing riparian areas and is the minimum riparian inventory method that the Forest Service is directed to do for riparian assessments. See Riparian section and Permitted Grazing section for more detail.

Proper Functioning Condition data – Green Ash Woodlands: Proper functioning condition inventory data were summarized for existing condition of green ash woodlands using a modified protocol from Bureau of Land Management. These data were primarily collected at various times since 1995 when the bulk of the National Environmental Policy Act analysis began for livestock allotment management. See "Permitted Grazing" section for more detail.

Fire Effects Information System Database: This national online database was used to help depict fire regimes, fire effects, and to assess fire and its relationship to trends.

Scale

A variety of spatial extents are used depending on the analysis element:

Custer Gallatin National Forest (also assessment area): The assessment area covers approximately 3,039,000 acres, including private land inholdings.

Landscape Areas: The Custer Gallatin National Forest is broken into five unique landscape areas ranging from roughly 78,000 acres to 2.3 million acres, including private land inholdings. Within the montane area are the 1) Madison, Henry's, Gallatin, Absaroka and Beartooth Mountain area; 2) Bridger, Bangtail, and Crazy Mountain area; and 3) Pryor Mountain area. Within the pine savanna area are the 4) Ashland Ranger District area; and 5) Sioux Ranger District area.

These two landscape areas depict ecologically different areas. The montane area includes the Hebgen Lake, Bozeman, Gardiner, Yellowstone, and Beartooth Ranger Districts and the pine savanna area includes the Ashland and Sioux Ranger Districts. These two ecosystem areas are nested within the broader ecoregions (Environmental Protection Agency Level III Ecoregions). An ecoregion provides a larger scale for planning and analysis that distinguishes common climatic and vegetation characteristics. Approximately 81 percent of the assessment area is in the Middle Rockies consisting of coniferous forest, alpine meadow, and shrubland-grassland steppe. Approximately 19 percent of the assessment area is in the Northwest Great Plains Province consisting of ponderosa pine – shrubland-grassland steppe. A small amount of the assessment area (less than 1 percent) is in the Wyoming Basin province around the Pryor Mountains consisting of semi- desert shrubland-grassland. Within the Custer Gallatin National Forest sections are identified as subdivisions with similar geomorphic processes, stratigraphy, geologic origin, drainage networks, topography, and regional climate. Sections are drawn at a coarse scale and designed to be modified as needed. The sections for the Custer Gallatin National Forest have been refined into two areas which are summarized as follows (USDA 1994).

Montane areas of the Custer Gallatin National Forest fall within the Middle Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow province. Pine savanna areas of the Custer Gallatin National Forest fall within the Great Plains- Palouse Dry Steppe Province.

The montane area is characterized by glaciated regions (most areas, not all) ranging with altitudinal zonation of semidesert vegetation, coniferous forests on the lower mountain slopes, and alpine tundra toward the top. Temperature and snowfall vary greatly with altitude. Winds are from the west/southwest, with much of their moisture precipitated where they cross the Pacific ranges. Due to aridity, forests are usually restricted to northern and eastern slopes. Although south- and west-facing slopes receive comparable precipitation, they are hotter and evaporation is higher. Consequently, they support fewer trees and are covered by shrubs and grasses. Lodgepole pine, Douglas-fir, subalpine fir, Engelmann spruce, limber pine, and whitebark pine are the predominant conifer vegetation. The lower slopes of the mountains are dominated by grasslands and shrublands.

The pine savanna area is characterized by rolling plains and tablelands of moderate relief. The plains are notably flat, but there are occasional valleys, canyons, and buttes. Badlands and isolated mountains break the continuity of the plains. The area lies in the rain shadow east of the Rocky Mountains. The climate is a semiarid continental regime. Winters are cold and dry, and summers are warm to hot. Evaporation usually exceeds precipitation, and the total supply of moisture is low. Vegetation is a formation class of short grasses usually bunched and sparsely distributed. Scattered and shrubs, such as sagebrush, are supported in all gradations of cover, from semidesert to woodland. Many species of grasses and herbs grow in this area. Grasses include grama, wheatgrass, and needlegrass. On the driest sites ponderosa pine is short and generally open growth with grass understories. Moist north-facing sites have dense stands of taller ponderosa pine, with shrub and herb understories, including species of the mountain forests to the west. Draws and gullies (ravines) that support many hardwood trees (green ash, box elder, aspen) and shrubs also dissect the landscape.

Some attributes are summarized at large scales to provide context and incorporates representative trends (that is, climate, wildfire, and insects). Most of the analysis occurs at the Custer Gallatin National Forest, ecosystem areas, or landscape area scales. However, some ecosystem components, such as species of special interest, are described at a more localized scale due to their ecological importance and/or limited distribution.

The temporal scale of analysis varies. Current condition analyses typically depict data collected within the last 5 to 15 years. Information currently available for historical vegetation describes conditions approximately 140 years ago and 50 years into the future. Assessments of trend include both short term and longer term predictions.

Current Forest Plan Direction

Custer Forest Plan

Green Ash Woodlands. Green ash woodlands or woody draws are recognized for their unique values and will be protected, managed, and improved. Woody draws are critical for the maintenance of deciduous trees and shrubs that provide valuable wildlife habitats. Forest Plan Management Area N (Custer) provides direction for management activities in these areas. Woody draw management area is difficult to map at the Forest Plan scale, but Forest Plan direction is to be used whenever these lands are encountered during Custer Gallatin National Forest activities. Woody draws areas are evaluated and mapped during project level analyses such as prescribed burning, allotment management, timber harvest and recreational use. Forest Plan goal for woody draws is to provide healthy, self-perpetuating riparian plant communities with diverse understory and overstory vegetation.

Use of prescribed fire in and near woody draws can be conducted to maintain or enhance the unique value associated within riparian zones, as well as a variety of successional vegetative stages.

Woody draws are to be identified and mitigation to be implement to retain unique values during project level allotment management planning for permitted livestock grazing. Management practices such as fencing, grazing deferment, burning or planting may be tried on selected areas to determine their effectiveness in maintaining or improving green ash woodland conditions. Large scale fencing efforts to protect these areas are generally not practical. Structural range improvements will be located to attract livestock out of this management area. Nonstructural range improvements will be done only to improve diversity of habitats or implement practices designed to restore the desired vegetative composition.

Riparian. Forest Plan goal for riparian areas is to provide healthy, self-perpetuating riparian plant communities with diverse understory and overstory vegetation. Riparian vegetation, including shrub and overstory tree cover, is to be managed along all perennial streams with defined channels to provide shade, to maintain streambank stability and in-stream cover, and to promote filtering of overland flows. Riparian areas are critical for the maintenance of water quality and deciduous trees and shrubs that provide valuable wildlife habitats. Direction includes managing for water quality, diverse vegetation, and key wildlife habitat in these areas from conflicting uses. Uses and activities that could adversely impact these areas are to be mitigated (see Aquatics and Riparian Report for further detail).

Grazing: Riparian areas are to be identified and mitigation to be implement to retain unique riparian values during project level allotment management planning for permitted livestock grazing. Adequate vegetation at the end of the growing season is important to provide streambank stability, protect streambanks from runoff events, and trap and filter potential sediment deposits. Desired vegetation that can meet these criteria are deep-rooted, water-loving species

Management practices such as fencing, grazing deferment, burning or planting may be tried on selected areas to determine their effectiveness in maintaining or improving the riparian zone conditions. Large scale fencing efforts to protect riparian areas are generally not practical. Structural range improvements will be located to attract livestock out of this management area. Nonstructural range improvements will be done only to improve diversity of habitats or implement practices designed to restore the desired vegetative composition.

Utilization standards are provided in the Gallatin Forest Plan while utilization guidelines are provided in project level decisions on the Custer National Forest. Regardless of where allowable utilization levels are found, in general, use is not to exceed 45 to 60 percent forage utilization by weight and not to exceed 35 to 50 percent browse utilization, depending on conditions and combined management prescriptions. Management grazing prescriptions (including allowable use levels, duration, timing, and rotations) are tailored for specific conditions found on individual allotments. Regional utilization guidelines were removed from policy several years ago since management prescriptions need to be done on a case by case basis at the allotment management scale. The allowable use standards for riparian areas currently found in the 1986 Gallatin National Forest Plan were designed after these now obsolete regional guidelines. The Custer Gallatin National Forest riparian area framework, developed by an interdisciplinary working group, provide similar allowable use guidelines with concepts of further restrictions in use levels depending upon severity of departure from desired conditions. These guidelines also recognize that there is a need for individual allotment management prescriptions where additional combined management prescriptions (that is, shortened duration, timing, improved distribution, etc.) might mitigate strict adherence to the framework's allowable use guidelines alone.

Timber Harvest. Forest Plan direction for timber harvest activities in or near riparian zones includes management prescriptions that will meet needs of riparian zone-dependent species, provide snag recruitment to create pools, enhance spawning gravels for fish habitat, emphasize special logging practices which minimize soil disturbance, and perform directional felling of timber where needed to protect the stream or associated riparian vegetation. Trees or products are not to be hauled or yarded across stream courses unless fully suspended or when designated crossings are used and machine piling is not allowed. Equipment use or time of the activity which causes excessive soil compaction and displacement is to be avoided.

Minerals. Common variety mineral permits are not to be issued in riparian areas. Surface occupancy for oil and *gas* exploration and development are not to be permitted in 100-year floodplains or within 500 feet of the high water mark.

Fire. Fire management strategies for unplanned wildland fire will be responsive to the goals and objectives described for each management area as specified in the Forest Plan. Use of prescribed fire in and near riparian zones can be conducted to maintain or enhance the unique value associated within riparian zones, as well as a variety of successional vegetative stages.

Conifer encroachment. Conifer encroachment control may occur where (1) Silvicultural prescription indicates the need, (2) Conifer species exist on sites capable of producing less than 20 cubic feet per acre that are invading rangeland habitat types may be removed in order to maintain the acreage of primary and secondary range. An assessment of wildlife values is required as part of the analysis for any control program, (3) Conifer species existing on sites producing more than 20 cubic feet per acre if the area has been managed as rangeland for some time and the long term objective is to manage for rangeland; and (4) In rangelands where the invading trees are less than 3-feet high, prescribed fire may be the preferred treatment. Mechanical methods may be used in areas where trees are over 3-feet high, including removal for Christmas tree purposes.

Grasslands and Shrublands. The Forest Plans call managing these lands for good condition. For the mixed grass pine savanna ecosystem, this has often been described as providing for a diversity of warm- and cool-season graminoid and forb species and structure that includes tall (for example: big blue stem, pine savanna cord grass, pine savanna sand reed), medium (for example western wheat grass, green needle grass, needle and thread, Idaho fescue) and short grass (for example blue grama, pine savanna June grass, sun sedge thread leaf sedge) species associated with mixed grass pine savanna communities.

For shrublands, it has often been described as providing a diversity of shrub communities (that is, Wyoming big sagebrush, silver sagebrush, buffalo berry, chokecherry). For mountain grassland ecosystems, this has often been described as providing a diversity of cool-season graminoid and forb species (that is, bluebunch wheatgrass, Idaho fescue, mountain brome, western needlegrass). For mountain shrublands it has often been described as providing a diversity of shrub communities (that is, mountain big sagebrush, Wyoming big sagebrush, ninebark). Management of shrublands will be based upon an approved assessment that includes management area wildlife habitat needs, and procedures that address the causes as well as the symptoms.

Noxious weeds are to be reduced and communities should exhibit or be progressing toward a healthy, productive, diverse population of native and or desirable plant species, and functioning disturbance processes appropriate to the ecological site capability.

Plant Materials[1]. Extraction of indigenous plant materials will be allowed under permit, either free-use or charge, depending upon the location and demand. The permit will designate the area, and the kind, size, and amount of plant material to be removed as well as the method of extraction. Plant materials will not be removed if inconsistent with management area goals, such as developed recreation sites or research natural areas. The opportunity to extract plant materials will be limited if it is expected to

[1] There are four laws that address non-timber harvesting activities in the national forests: The Organic Act of 1897, the Multiple-Use Sustained Yield Act of 1960, The Forest Rangeland Renewable Resources Planning Act of 1974, and the National Forest Management Act of 1976. Though these laws imply that national forests will manage non-timber forest products, there is no explicit mandate to include these products in forest management plans and activities.

create unfair competition to local private nurseries. Removal of threatened and endangered or State-protected plant species will not be allowed.

Rangeland Insect Infestations. The Animal Plant Health Inspection Service has the delegated responsibility for control of range pests on National Forest System lands. Pesticide use proposals will be completed for all projects. Any proposed action must be evaluated through an environmental analysis to determine the impacts on other resources in accordance to the memorandum of understanding with the Animal Plant Health Inspection Service. National Forest System lands will not be treated unless all infested lands (private, State, or Federal) which make up a natural unit are treated. Pre- and post-treatment evaluation will be conducted by the Animal Plant Health Inspection Service.

Gallatin Forest Plan

Vegetative Diversity. Forest lands and other vegetative communities such as grassland, aspen, willow, sagebrush, and whitebark pine will be managed by prescribed fire and other methods to produce and maintain the desired vegetative conditions.

Existing Condition

With the settlement of the area came mining, trapping, grazing, timber harvest, and fire suppression. In the last 200 years or so, increased human-caused changes to the landscape affected historic ecosystem processes. These activities altered and sometimes reduced of some wildlife species and/or their habitats.

Key Ecosystem Components

An ecosystem is defined as a spatially explicit, relatively homogeneous unit of the earth that includes all interacting organisms and elements of the abiotic environment within its boundaries (Forest Service Handbook 1909.12). Ecosystem integrity is the condition where natural ecological composition, structure, and processes are essentially intact and self-sustaining. This indicates that the ecosystem is able to evolve naturally with its capacity for self-renewal and biodiversity maintained. Ecosystems are described in terms of structure, composition, function, and connectivity (Code of Federal Regulations 219.8). Composition refers to the types and variety of living things. Structure is the physical distribution and character of components of the ecosystem. Function is the processes or interactions that occur among the living elements of the ecosystem; connectivity is the spatial linkage among them.

Key ecosystem characteristics are identified based on the dominant ecological characteristics that describe ecosystems. Indicators and measures are identified for each. Some key characteristics are agents of change and may be referred to as drivers. Some characteristics may be carried forward to inform Forest Plan components and/or long term monitoring plans depending on their relevancy to coarse and fine filter ecosystem diversity. Table 1 describes key ecosystem components for non-forested ecosystems.

Table 1. Key ecosystem components – non-forested ecosystems

	Key Ecosystem Component	Description
Structure and Composition	Diversity of vegetation	Diversity of life forms, cover types and successional stages
	Rare communities and special habitats	Habitats such as riparian, green ash woodlands, sagebrush, aspen, cottonwood, juniper, limber pine, alpine
	Ground cover	Amount of ground cover for soil stability
	Invasive species	Presence and abundance of nonnative, invasive species
Pattern and Process	Fire	Fire regimes
	Climate/Drought	Climate influences and trends
	Herbivory	Herbivory influences and trends

Structure and Composition

Diversity of Vegetation

General Landscape Diversity Description

The following describes the general diversity of vegetation found by landscape area.

Bangtail, Bridger, and Crazy Mountains

The montane vegetation in the Bangtail, Bridger, and Crazy Mountains are composed of alpine ridges, mountain peaks, cirques, moraines, tundra plateaus, coniferous forests, meadows, and foothill grasslands. The Bridger Mountains is an isolated range in the northwestern part of the assessment area. The range is capped by Mesozoic sedimentary rocks, which lie on top of Paleozoic and Precambrian formations. Madison limestone is exposed extensively in the range (Vanderhorst, 1994). The spectacular cirque above Fairy Lake is evidence of glaciation in the range. The mountains rise from about 5,000 feet at their western base in the Gallatin Valley to just over 9,600 feet on Sacagawea Peak. Vegetation types in the Bridgers include riparian woodlands and thickets, sagebrush grasslands, montane to alpine meadows, coniferous forests, and rock outcrops. Habitat on the west side of the range is somewhat warmer and dryer and the slopes are mostly unforested; the patchy coniferous forests are dominated by Douglas fir. On the east side at upper elevations, Engelmann spruce and subalpine fir forests are common. The tree line in the Bridgers is generally around 9,000 feet and is somewhat lower on the east side of the crest. The highest elevations in the range support an alpine flora. Plants restricted to limestone substrates constitute another conspicuous element.

The Crazy Mountains is another isolated range, also in the northwestern part of the Custer Gallatin National Forest. Land ownership, unlike the continuous national forest tracts of the Bridgers, is a checkerboard pattern of national forest and private sections. The northern part of the range, lies on the Lewis and Clark National Forest. The Crazy Mountains are geologically unique in Montana, composed of resistant igneous intrusions and "hard baked sedimentary rocks" (Vanderhorst, 1994). The igneous rocks in the northern part of the range are rich in sodium and potassium, but alkali metals are less abundant in the southern part of the range. The Crazy Mountains, like the Bridgers, were shaped by isolated mountain glaciers during the Pleistocene, and some small glaciers persist today. The Crazy Mountains are higher than the Bridgers, rising to over 11,000 ft. on Crazy Peak.

Vegetation types include coniferous forests, montane to alpine meadows, seep areas, and most common of all, sparsely-vegetated rock faces, slides, and boulder fields. Highly developed alpine flora occurs in the basin of Sunlight Lake, where patches of tundra occur within the otherwise continuous rocky landscape.

Madison, Henrys Lake, Gallatin, Absaroka and Beartooth Mountains

The montane vegetation in the Madison, Henry's, Gallatin, Absaroka and Beartooth Mountains is underlain by granitic, volcanic, and some sedimentary parent material. The setting is composed of alpine ridges, mountain peaks, cirques, moraines, tundra plateaus, coniferous forests, meadows, and foothill grasslands. Montana Natural Heritage Program cites 188 vegetation types around the mountainous areas (Yellowstone Highland Ecological Setting). The alpine areas alone contain over 400 plant species. Roughly 50% of the Beartooth Mountain flora is also found in the Arctic. The flanks of Line Creek Plateau provide habitat for some of the Bighorn Basin endemic and globally rare species.

Pryor Mountains

Pryor Mountain vegetation is largely influenced by sedimentary / limestone parent material. The setting is composed of subalpine meadows and ridges, montane coniferous forests, meadows, foothill grasslands, and semi-desert. The Pryor Mountain area is a place of climatic, physiographic, and geologic diversity resulting in exceptional biological diversity.

This area is where three floristic provinces converge; the Northwestern Great Plains province to the north and east, the Wyoming Basin province to the south, and the Middle Rockies province to the west (Environmental Protection Agency Level III Ecoregions). Each of these provinces possesses a unique climate and resulting floristic expression. Within a relatively short distance of about 20 miles, one can find dramatically different vegetation types from semi-desert to subalpine areas. The vegetation changes from the drier southern portion of Wyoming Basin desert shrubs, the drier eastern portions of the Northwestern Great Plains mid and short grass Pine Savannas to the higher elevations of the Middle Rockies montane settings. McCarthy (1996) compared the flora of the Pryor Mountain area with 11 other floristic surveys from the western United States, which represented the three cited floristic provinces. The Pryor Mountain flora was found to be more diverse than comparative floras.

Because of this unique convergence of three floristic provinces, the Pryor Mountains are considered a "botanical hotspot", rich in species and community diversity. This area has been found to have high levels of endemism where plant species[2] (eight) that are globally rare are found only in the Pryor Mountains and Bighorn Basin area. Although none of these species are currently considered threatened, areas of high endemism are important targets for conservation to prevent future extinctions (Lesica, 2012b).

The Pryor Mountains contain the eastern most extent of Douglas-fir in Montana and the northern most extent of Utah Juniper (predominantly known from the Great Basin to the south). Five percent of the Pryor Mountain flora is composed of northern range extension of southern desert species (McCarthy, 1996). Found at the lower elevations of the National Forest portion of the Pryor area, some species of desert plants reach the northern limit of their range. Many plant communities common in the Great

---

[2] These endemics are Bighorn Fleabane (*Erigeron allocotus*), Cary's Penstemon (*Penstemon caryi*), Pryor Bladderpod (*Physaria* lesicii), Wyoming Sullivantia (*Sullivantia hapemanii*), Beartooth Goldenweed (*Haplopappus carthamoides subsquarrosa*), Shoshonea (*Shoshonea pulvinata*), Rabbit Buckwheat (*Eriogonum brevicaule canum*), and Wooly Prince's-Plume (*Stanleya* tomentosa). The first four of these occur only in the Pryor Mountains of Montana and adjacent northern Bighorns of Wyoming. Beartooth Goldenweed and Shoshonea are found in the foothills of the Pryors and eastern Beartooth-Absaroka uplift, while Rabbit Buckwheat and Wooly Prince's-Plume occur in the Bighorn Basin desert.

Basin deserts reach their northern limit here (DeVelice and Lesica, 1993). Although not all occur on the National Forest System portion of the Pryor area, more than 30 species with affinities to cold desert floras occur at the northern limit of their range at low elevations on the south side of the Pryor Mountains (Lesica, 2012b). Peripheral populations of species and their habitats are often important areas for genetic divergence and speciation. Populations occurring on the edge of a species' range tend to be smaller, more isolated, and more genetically and ecologically divergent than central populations. The combination of these characteristics can impart evolutionary potential and local ecological significance, thus heightening their conservation value (Leppig and White, 2006 and Lesica, 2012b). Conservation of important peripheral populations, despite the commonness of the species elsewhere, are generally considered by state natural heritage programs and the Forest Service when assigning conservation values.

More than 25 plant communities of those identified by Montana Natural Heritage Program (MTNHP, 2002) occur within about 5,000 feet of vertical relief in the Pryor Mountains. Local botanists have developed a botanical guide to nine of those plant communities for visitor exposure to understanding the ecological components and settings (Lyman, Flathers, and Durney).

The adjacent Bureau of Land Management lands are also floristically rich and diverse. Hartman and Nelson's recent floristic survey (2010) observed about 390 species on National Forest System lands and a similar amount on adjacent Bureau of Land Management lands. About 25 grass and shrubland habitat types have been described (Stewart and Mueggler, 1988) in the Pryor Mountain area on Bureau of Land Management lands with some of those occurring within National Forest System lands. Seventeen plant lists have been compiled from various botanists studying the Pryor Mountains, McCarthy documented 981 vascular plant species which represent 71 plant families in a 316,000 acre study area (McCarthy, 1996). This is about 40 percent of the plant species that grow in all of Montana (Ostovar, 2012). Even though the national forest portion of the Pryor Mountains is about a quarter of McCarthy's study area, species diversity and richness is still apparent.

Due to the botanically rich area, the Montana Native Plant Society designated close to 115,000 acres of National Forest System lands, Bureau of Land Management lands, and other lands as an important plant area in the southern Pryor Mountain area (Hanna and Lesica, 2012).[3] National Forest System lands constitutes about 40 percent of the important plant area. Important plant area recognition is a means of making land managers aware of the special value of the land they manage. The important plant area program has no regulatory authority. The goal of the Montana Native Plant Society's Important Plant Areas Program is to identify the most important sites for plant conservation across Montana using consistent criteria. An important plant area supports an exceptional population of one or more globally rare plants or an exceptional assemblage of plants rare or threatened in Montana. The South Pryor Mountains important plant area encompasses 19 vascular plant species of concern[4] and one lichen species of concern with about 40 populations being known to occur on National Forest System portion of the important plant area. Also included are five globally rare species endemic[5] to the north end of

---

[3] Other designations found within the 114,950 acre South Pryor Mountains Important Plant area include East Pryor Mountain Area of Critical Environmental Concern (BLM), Lost Water Canyon Research Natural Area (USFS), Burnt Timber Canyon Wilderness Study Area (BLM), Pryor Mountain Wilderness Study Area (BLM), Pryor Mountain Wild Horse Range (BLM), Bighorn Canyon National Recreation Area (NPS), and Bear Canyon Important Bird Ara (Audubon, USFS, BLM).

[4] The phrase "species of concern" is used by the Montana Natural Heritage Program to refer to plant species that are rare or threatened to become rare by natural or human impacts and have declining numbers that could result in the loss of the species altogether.

[5] A species is labelled "endemic" to an area when it grows only in that area. An endemic species may be either rare or abundant, but it grows naturally only in that area and nowhere else.

the Bighorn Basin in Montana and Wyoming. The majority of the rare plants (14) have affinities to the Great Basin flora. They are more common in Wyoming and Utah but reach the northern margin of their range in the South Pryor Mountains area.

In recognition of the unique landscape and species diversity, a "BioBlitz" was conducted in 2012 by 80 researchers, government agency specialists, and interested community naturalists in the southern portion of the Pryor Mountain area. The main objective for the Pryor Mountain BioBlitz was to gather a large amount of data in a short period (generally a minimum of 20 hours each) and help raise awareness about the important ecology of the Pryor Mountains. About 700 species were recorded which included over 315 plant species, 50 spiders species, 25 grasshopper, katydid and cricket species, about 90 pollinators (bees, wasps, butterflies), 83 bird species, and 104 fly species. This is indicative of the diversity found in the area.

Ashland and Sioux Districts

The Ashland and Sioux Districts stand out from the surrounding pine savanna because of their elevation and the ponderosa pines. Vegetation varies from dense stands of pine, green ash hardwood draws, and sagebrush to open, grassy uplands. Sandstone cliffs, ponderosa pines, grasslands, all intersperse by draws and ridges, are typical. A recent floristic survey of the Sioux and Ashland Districts identified a total of 622 unique taxa in 83 families. Five hundred and fifty plant species are known from the Sioux District and about 470 from Ashland (Hallman 2012). Minor populations of paper birch (*Betula papyrifera*), a more boreal species, are found on the Sioux RD. These isolated southern populations are a relic from the last ice age. Minor populations of Idaho fescue, a more montane species, can be found in the higher elevations within these landscape settings. Unlike the montane units where cool season grasses dominate, there is a mix of cool season and warm season grasses found in this landscape area.[6] On the Sioux District, a transition zone occurs between the eastern edge of the sagebrush distribution and the western edge of the mixed grass prairie. These sagebrush communities are on the periphery of their distribution which can be an important consideration for sage-grouse habitat management (Swanson et al., 2013).

Harding County, SD Local Evaluation. The South Dakota portion of the Sioux District (74,006 acres) is found in Harding County (1,713,920 acres). According to a 100-year comparison study conducted in Harding County recently, the overall vegetation is apparently in good condition based on plant species composition, richness, and coefficients of conservatism[7] (Gabel et al., 2014). The consistency of plant

---

[6] Cool season and warm season grasses use different leaf anatomies to carry out photosynthesis. The differences are reflected in how plants take carbon dioxide from the atmosphere and use the components for plant functions. Warm-season grasses are generally categorized as species that excel during the hottest months and die or go dormant during cooler seasons. Warm-season grasses generally germinate or break dormancy when soil temperatures exceed 60 to 65 degrees F. Growth slows as fall temperatures cool and the plants shut down (senesce) after a hard freeze. These species are known for drought tolerance and thriving in extreme heat. While many warm-season grasses have good quality forage, as a whole, cool-season grasses are higher in forage quality.

[7] Floristic quality assessment can be used to facilitate comparisons among different areas, to provide long- term monitoring of an area's quality, and to evaluate habitat management. To facilitate floristic quality assessments in North Dakota, South Dakota, and adjacent grasslands, a panel of experts assigned a species coefficient of conservatism (C value; range = 0 to I0) to each plant species in the region's flora. The value assigned represented a collective knowledge of the pattern of occurrence of each plant species in the Dakotas and the confidence that a particular taxon is natural-area dependent. "C values" of 4 or higher to 77% of the native taxa, and the entire native flora had a mean C value (C) of 6. 1. A floristic quality index (FQI) can be calculated to rank sites in order of their floristic quality. By applying the coefficients of conservatism (C value) and calculating FQI, an effective means of evaluating the quality of plant communities can be obtained. Additionally, by repeating plant survey and calculation of C and FQI over time, temporal change in floristic quality can be identified.

species, habitat types, life cycle durations, and plant groups, the high numbers of native species and the relatively large values for species coefficient of conservatism and floristic quality indices indicated that the vascular flora of Harding County has remained relatively stable since Visher's 1914 work.[8] The study indicated that there was a relatively small change (less than 6 percent) that has occurred in plant species duration, species habit, or major groups over 100 years. The largest change observed was a 5 percent increase in grass and grass-like species probably as a result of more thorough collection and study of grasses and sedges. The most obvious change in the vegetation was the increase of introduced species from five percent in 1914 to 13 percent in 2014. Percent of life form types indicated only slights changes over the 100-year timeframe with forbs being the largest at just under 70 percent, grass and shrubs near 10 percent and sedges, vines, ferns, and trees being at less than about 5 percent for each lifeform category. Percent of life cycle types indicated only slight changes over the 100-year timeframe with perennials being the largest at just over 70 percent, annuals being at near 20 percent, and annual, biennial, or perennial grouping being near 10 percent (Gabel et al., 2014).

Potential Vegetation Types

The chances of sustainable resource management are greater if the variation in managed ecosystems is not greater than the range of conditions that are expected at various scales in ecosystems relatively uninfluenced by humans.

Potential natural vegetation is based on climax successional theory which states that vegetation communities are constantly changing and moving toward an endpoint, or "climax" (Pfister et al. 1977). Potential natural vegetation can be represented by classification systems that define *potential vegetation types* to describe the climax state. Plant communities that would develop over time given no major disturbances are similar within a potential vegetation type. Thus, they serve as references to understand site productivity, biodiversity, pattern of existing and future vegetation, growth potential, species distribution, and disturbance type and frequency. Potential vegetation types are not used to suggest that the climax state is desirable or achievable given the role of natural disturbance. Existing vegetation represents a single point along the successional pathway of a potential vegetation type and varies depending on each site's unique history.

Habitat types (that is, Pfister et al. 1977; Mueggler and Stewart 1980; USDA 2005a, Hansen and Hoffman, 1988, and Hansen et. al, 1995) are used to classify potential vegetation. Many individual habitat types have been defined; these are grouped into associations with similar characteristics. The Custer Gallatin National Forest utilize mid-scale habitat type groups to describe ecosystem diversity, which nest within broader groups. These groups provide the basis to define ecosystems. Habitat types are a relatively static concept; therefore, using them to stratify and estimate key characteristics provides a meaningful depiction of ecosystem diversity. The groups described are based on habitat types; other factors such as soil type greatly influence the biophysical settings upon which non-forested communities develop. Table 2 summarizes non-forested habitat type groups used to inform biological diversity on the Custer Gallatin National Forest.

[8] Unregulated grazing (~1870 and forward) took place in the area before Visher's 1914 work, thus it is unknown what vascular flora of Harding County might have been lost before Visher's compilation.

Table 2. Non-forested potential vegetation groups[9] for the Custer Gallatin National Forest

Broad Potential Veg Group	Habitat Type Group	Description[1]
Grassland	Bluebunch wheatgrass	The driest grassland potential vegetation type, where bluebunch wheatgrass responds well after fire and can dominate early seral communities. Bare soil, clubmoss, and invasive species are common on these low productivity sites after disturbance. Mid and late seral communities contain high proportions of native grasses and forbs.
	Western wheatgrass	Annual grasses, annual forbs, and shallow-rooted perennial short grasses dominate early seral stages. Perennial plants become dominant in later seral stages, including native warm- (blue grama) and cool-season grasses and forbs.
	Fescue	The most mesic and productive grasslands in which communities have greater amounts of mesic forbs, higher cover, and more species richness than other grassland types. Annual grasses and forbs, introduced grasses and forbs, and sometimes clubmoss dominate early seral conditions, with bare soil prominent. Mid and late seral stages become dominated by native grasses such as Idaho fescue and forbs.
Mesic shrubland	Mesic Shrubland	Mesic shrublands are characterized by dense canopy cover of mesic shrubs forming continuous thickets, often via cloning. Most species are root crown sprouters and respond well to natural fire. Species present include chokecherry and snowberry.
Xeric shrubland / woodland	Low shrubland	Shrublands at the hottest and driest sites at low elevations. Low and perhaps black sagebrush are the overstory dominants, usually with low cover. Rubber and green rabbitbrush and white horsebush may be present along with dry grasses such as bluebunch wheatgrass, needle-and-thread, and Sandberg bluegrass in the understory. Natural fire would promote a mosaic of conditions of native plant associates.
	Mountain shrubland	Higher elevations mesic sites, often dominated by mountain big sagebrush at low to moderate cover with high cover of graminoids and forbs. Sagebrush may have higher cover in communities altered by grazing. Natural nonlethal and mixed severity fire promote a mosaic of sagebrush which regenerate via seed, along with the fire-sprouting species threetip sagebrush, rubber and green rabbitbrush, and white horsebrush. Natural fire may increase sprouting shrubs and promote a mosaic of native plants.
	Xeric shrubland	Low elevation, hot, dry sites where Wyoming and basin big sagebrush are the overstory dominants with low to moderate cover. Rubber and green rabbitbrush and white horsebush may be present. Dry grasses such as bluebunch wheatgrass, Sandberg bluegrass, and needle-and-thread dominate undergrowth. Nonnative annual grasses and noxious weeds may be present. Regrowth following fire tends to be slow.
	Juniper woodland	Juniper woodlands can be split into two groups based on ricegrass or bluebunch wheatgrass understories. Both types are dry. The ricegrass type is slightly more mesic, and succession involves an initial grassland stage followed by a mesic shrub stage, green ash stage, and then juniper dominance. The bluebunch wheatgrass type is drier. After the early grassland stage, juniper becomes dominant with no intermediate stages.
	Green ash woodland	Green ash woodlands in xeric settings are dominated by green ash and typically associated with moister hillslope areas.
Riparian / wetland[10]	Green ash woodland	Green ash woodlands in riparian settings are dominated by green ash.

[9] Manning 2009

[10] Riparian and wetland vegetation are addressed in detail in the Riparian section of the assessment.

Broad Potential Veg Group	Habitat Type Group	Description[1]
	Aspen woodland	Aspen woodlands are dominated by aspen at later stages in succession and typically associated with riparian areas or wet hillslope areas.
	Riparian/ wetland	This group includes riparian shrub types on wide valley bottoms, occupied by dense willow or riparian shrubs. These types also occupy stream banks and benches in narrow, steep valley bottoms where shrub cover ranges from continuous to spotty and conifer encroachment is common. Riparian shrub/graminoid types occur on wide flat valley bottoms with a mosaic of shrubs and herbaceous vegetation. Wetland graminoid types are characterized by dense, continuous cover of rhizomatous sedges, rushes, and grasses, with mesic and hydric forbs. The riparian deciduous tree type is characterized by cottonwood with shrubs, forbs, and graminoids in the understory.
Alpine	Alpine herbaceous and shrub	Alpine types occur above treeline; they occupy the highest mountaintops and ridges. Sites are harsh with frost heaving, minimal soil development, low nutrients, wind deflation, and short growing seasons. Alpine herbaceous types have low to moderate cover of graminoids and forbs. The alpine shrub type supports various communities, including artic willow, mountain avens, mountain and moss-heather.
Unassigned	Sparse vegetation	Sparsely vegetated areas are areas such as badland settings in the Pine Savanna units and those areas covered with rock, ice, or snow where a potential vegetation type is not identified or not discernable.

From forest inventory and analysis plot data, the montane units are estimated to have potential for about 15% non-forested and 85 percent forested habitat type groups while the pine savanna units are estimated to have potential for about 32 percent non-forested and 68 percent forested habitat type groups as noted in Table 3.

Table 3. Forested and non-forested potential by habitat type groups within assessment montane and pine savanna areas (forest inventory and analysis).

R1 Broad Habitat Type Group	Montane	Pine Savanna
Non-Forested		
Xeric Grassland	<1%	5%
Mesic Grassland	3%	10%
Xeric Shrubland / Woodland	2%	16%
Mesic Shrubland	<1%	<1%
Riparian / Wetland /Moist Woodlands	<1%	1%
Alpine	2%	<1%
Sparsely Vegetated	7%	<1%
Non-Forested Subtotal	15%	32%
Forested		
Cold	36%	0
Cool Moist	30%	0
Warm Moist	<1%	0
Warm Dry	18%	65%
Forested Subtotal	84%	65%
No Data	1%	3%
Total	100%	100%

Table 4 displays forest inventory and analysis estimates for potential forested and non-forested vegetation by broad habitat type groups by landscape area.

Table 4. Potential forested and non-forested vegetation by landscape area (forest inventory and analysis).

R1 Broad Habitat Type Group	Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	Bridger, Bangtail, Crazy Mtns	Pryors	Ashland	Sioux
Non-Forested					
Xeric Grassland	0%	0%	0%	5%	3%
Mesic Grassland	3%	6%	8%	5%	22%
Xeric Shrub Woodland	1%	1%	17%	13%	26%
Mesic Shrub	0%	0%	0%	0%	2%
Riparian Wetland	1%	0%	0%	2%	0%
Alpine	2%	0%	0%	0%	0%
Sparsely Vegetated	7%	5%	2%	0%	0%
Non-Forested Subtotal	15%	12%	27%	24%	53%
Forested					
Cold	38%	32%	8%	0%	0%
Cool Moist	30%	27%	21%	0%	0%
Warm Moist	0%	1%	0%	0%	0%
Warm Dry	16%	28%	37%	72%	47%
Forested Subtotal	85%	88%	65%	72%	47%
No Data	1%	0%	8%	3%	0%

Diverse array of plant species and described habitat types/community types/plant associations occur within the plan area (Pfister, et. al., 1977; Mueggler and Stewart, 1980; Hansen and Hoffman, 1988; Girard et al., 1989; Jensen, et al., 1992; DeVelice and Lesica, 1993; Girard, 1997; Hansen, et al., 1995; and Walford, et al., 1980). Table 5 and Table 6 depict the approximate amount and mix of diverse types.

Table 5. Custer Gallatin National Forest habitat types/community types/plant associations (HTs/CTs)

Plan Area Vegetation Groups	# of HTs/CTs/Exotic Types
Alpine / Subalpine	30
Riparian - Coniferous	29
Riparian – Deciduous Woodlands	21
Riparian - Herbaceous	33
Riparian - Shrublands	40
Deciduous Woodlands	7
Upland - Forb	3
Upland - Forested	17
Upland - Grasslands	33
Upland - Shrublands	26
Noxious Weeds	10
Naturalized Exotic Grasslands	5
Grand Total	256

Table 6. Custer Gallatin National Forest estimated # plant species and # HTs/CTs by landscape area

Area	# Plant Species	# of Habitat Types (HTs)/Community Types (CTs)
Alpine of the Bangtail, Bridger, Crazy, Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	est. ~430 to 450	~30 alpine/subalpine HTs/CTs
Bangtail, Bridger, Crazy Mtns	est. ~400	~20 non-forest; 7 forested & several CTs
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	~400	~20 non-forest; 7 forested & several CTs
Pryor Mtns	~390	~25 non-forest; 6 forested & several CTs
Ashland	~470	~32 non-forest; 5 forested & several CTs
Sioux	~550	~26 non-forest; 5 forested & several CTs

Existing Vegetation Types

Existing vegetation is not the same as potential vegetation; the array and condition of the species currently present on a site represent just one point along the successional pathway represented by a potential vegetation type. Species composition is complex; composition changes through time based on successional pathways and disturbances. Cover types and life forms are not static and can change at any point in time, especially when cover type disturbances occur. Cover type disturbances will reset the life form from tree to shrub, shrub to grass, and forb or grass depending on site characteristics and other vegetation types present. Without disturbance existing vegetation slowly transitions from early seral, to mid seal to late seral vegetation.

About 70 percent of the Custer Gallatin National Forest lies within some type of designated area including wilderness, inventoried roadless areas, research natural areas, and wilderness study area. Special area designations tend to reduce the amount of human-caused disturbances, so generally succession of the included non-forested vegetation tends to proceed toward late seral conditions in these areas (barring natural disturbance). Wilderness areas, wilderness study areas, and research natural areas are generally managed to promote "natural" succession and disturbances.

One broad depiction of existing vegetation types is categorizing vegetation as forested or non-forested. In the Montane unit, forested vegetation (conifer species including pines, firs, spruces) occupies 61 percent of the landscape, transitional forest (recently burned forested vegetation) occupies 7 percent and non-forest vegetation (conifer woodland species including juniper and limber pine, broadleaf trees including aspen, cottonwood, green ash woodlands, and paper birch), riparian/wetland vegetation, grassland / shrublands, sparse vegetation, and alpine) occupies 16 percent. In the pine savanna unit, forested vegetation occupies 29 percent of the landscape, transitional forest (recently burned forested vegetation) occupies 14 percent, and non-forest vegetation occupies 56 percent (Region 1 existing vegetation database). See Table 7. The potential for forested conditions are estimated to be higher than existing forested cover types which is due to recent large-scale wildfires shifting existing vegetation.

Table 7. National Forest System acres and proportion of existing vegetation: forested, non-forested, and transitional forested vegetation (Region 1 existing vegetation database)

Landscape Area	Forested (Conifer)	Non-Forested	Non-forested - Transitional Forest (burned)	Unit NFS Ac
Montane				
Madison, Henry's, Gallatin, Absaroka and Beartooth	1308022	335909	171105	2157246
Bridger, Bangtail, Crazy	142921	25694	2385	205008
Pryor	41785	29686	2936	75067
Montane Subtotal	1492729	391289	176426	2437321
%	61%	16%	7%	85%
Pine Savanna				
Ashland	140462	215350	76439	436124
Sioux	32635	121810	5792	163982
Pine Savanna Subtotal	173097	337160	82231	600106
%	29%	56%	14%	99%
Grand Total	1665826	728449	258657	3037427
%	55%	24%	9%	87%

Non-Forested Cover Types. The composition of existing vegetation is further characterized by cover types, which describe the more predominant species making up the variety of vegetation. There are many existing vegetation types on the Custer Gallatin National Forest. These types are grouped into meaningful associations, or *cover types*. Table 8 describes the cover types found within the assessment area and their relationship to potential vegetation (i.e. habitat types/groups). Appendix A provides detailed information on cover types (VMap 2015) by assessment area.

Table 8. Existing non-forested cover types

Cover Type	Description
Riparian Grass/ shrub	This cover type can occur in riparian areas, typically non-forested woodland or riparian habitat types, but also potentially in forested habitat type groups such as Cool and Wet. This type includes species such as willow, alder, mountain brome, smooth brome, dry sedge, wet sedge/spikerush/juncus, and annual brome.
Grass	Grass can dominate most non-forested habitat types, and in some cases forested habitat types. Species can include forbs; rough fescue; Idaho fescue; western wheatgrass; bluebunch wheatgrass, needle-and-thread grass; tufted hairgrass; little bluestem; Pine Savanna sandreed; green needle grass; needlegrass; wheatgrass; Timothy; crested wheatgrass; blue grama; Kentucky bluegrass; bluegrass; cool season short grass mix; cool season mid grass mix; warm season mid grass mix; and warm season short grass mix.
Dry Shrub	The dry shrub cover type may occur on most non-forested habitat types as well as some forested habitat types. Shrubs include sagebrush; antelope bitterbrush; shrubby cinquefoil; skunkbush sumac; curl-leaf mountain mahogany; greasewood; rabbitbrush; low shrub; saltbush, spineless horsebrush; soapweed yucca sagebrush, and rabbitbrush. These areas may also contain limber pine and juniper, especially in ecotones.
Mesic Shrub	Mesic shrubs most commonly dominate mesic shrub habitat type groups. Species may include chokecherry, plum; rose; snowberry; huckleberry; mallow ninebark; white spirea, and buffaloberry.
Juniper / Limber Pine	Evergreen woodlands in xeric settings include juniper and limber pine.

Cover Type	Description
Green Ash Woodlands	Areas dominated by green ash, boxelder, chokecherry, often with shrubs such as snowberry. This type often occurs in association with riparian and moister upland areas. Without disturbance, conifers will eventually dominate. This cover type is found interspersed among habitat type groups found only on the Ashland and Sioux Districts.
Aspen / Cottonwood	Areas dominated by aspen, cottonwood, and birch, often with shrubs such as willow and alder. This type often occurs in association with riparian and moist upland areas. Without disturbance, conifers will eventually dominate. This cover type can be found in almost all habitat type groups.
Sparsely Vegetated	Sparsely vegetated areas include areas with less than 10% cover of grass, shrub, or tree cover. These often occur in areas dominated by rock, ice, and snow or dominated by sparse vegetation in the badland settings of the Pine Savanna units.

Rare Communities and Special Habitats

Plant communities are grouped into similar associations or groupings for discussion purposes as they have often been of highlighted interest to the public or resource specialists. The values placed on these associations include considerations such as high value or limited wildlife habitats, recreational uses, cultural uses, or importance to ecosystem diversity. The following are plant community groups being assessed as special and/or rare habitats: Riparian and wetland vegetation (that is, willows, birch, sedge), grasslands / shrublands, juniper and limber pine woodlands, aspen/cottonwood and green ash woodlands, sparse vegetation, and alpine. In addition to other non-forest plant species of interest include species with some commercial harvest interest such as Echinacea (*Echinacea angustifolia*) and culturally important plant species are considered in this assessment.

Whitebark pine is also considered a special habitat, especially with its association with grizzly bear habitat needs. Assessment of white bark pine habitat is found within the Terrestrial Ecosystems – Forested Vegetation Report. Paper birch (*Betula papyrifera*) is known to exist on the Sioux District close to the southern edge of its range. Presence is very rare with only four small stands (less than 0.5 acres each) that have been identified.

A separate report assesses “At Risk” plant species and potential plant “Species of Conservation Concern” (see Plant Species of Concern Report for detailed information).

Riparian Vegetation

Background

Riparian areas and wetlands are rare and important elements of the ecosystem which can be described based on potential vegetation, existing vegetation, topography, and hydrological features. A small proportion of the Custer Gallatin National Forest consists of riparian/wetland vegetation (3 percent).

Riparian systems occur along creeks and rivers and occupy floodplains, stream banks, islands in rivers, narrow bands in steep channels, and backwater channels. This system is dependent on a hydrologic regime that has annual to episodic flooding. It is often comprised of a mosaic of communities dominated by trees but also includes a diverse shrub and herbaceous component. The dominant tree species are black cottonwood, aspen, and green ash although other dominant tree species may exist on drier sites, Dominant shrubs may include several species of willow, mountain alder, river birch, dogwood, hawthorn, and on drier sites includes chokecherry, rose, silver buffaloberry, Rocky Mountain maple and/or snowberry.

Wetlands are characterized by standing water or season long inundation with a dominance of vegetation adapted to saturated, anaerobic soil conditions. They include wet meadows, swamps, marshes, fens, carrs, and similar areas. Soils exhibit characteristics of hydric conditions and are generally either mineral or organic. The accumulation of large amounts of organic material in some wetlands creates distinctive water chemistry. The vegetation complex is usually represented by a mosaic of herbaceous and woody plant communities. Many species occupying wetlands have rhizomatous root systems that provide excellent erosion control. Low willow species and bog birch are often the dominant woody species in a wetland system. Herbaceous species may be dominated by cattails, sedges, spikerushes, rushes, and/or bulrushes. Bryophytes, including sphagnum, are often well represented in fens.

Table 9 displays riparian / wetland vegetation cover types. See the Aquatics and Riparian Report for further detail.

Table 9. Riparian vegetation cover types and acreage by landscape area (National Forest System)

Landscape Area	Aspen (%)	Cottonwood Green Ash* (%)	Graminoid** (%)	Shrub (%)	Total Acres Riparian Vegetation	Total Acres Riparian Corridor***	Grand Total Riparian (acres)	% of Landscape Area Riparian
Montane								
Bridger, Bangtail, Crazy Mtns	45	<1	38	17	2036	3429	5465	3
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	20	1	72	7	25466	42229	67695	3
Pryor Mtn	25	1	7	67	163	2115	2278	3
Montane (%)	22	1	69	8	27665	47772	75438	3
Pine Savanna								
Sioux	Trace*	59	36	5	1259	NA	1259	1
Ashland	Trace*	87	4	9	843	NA	843	<1
Pine Savanna (%)	Trace	70	24	6	2102	NA	2102	<1
Grand Total					29767	NA	77540	3

*Aspen and cottonwood are present on the Pine Savanna units but are not the dominant species; green ash is only present on Pine Savanna units.

**Moist site grass and grass-like vegetation (e.g. sedges).

***Non-riparian vegetation dominates but riparian processes still at play (e.g. conifers dominate, but within recruitment zone of stream channel). Typical vegetation types: Douglas fir, Engelmann spruce, lodgepole pine, dry site grasses.

About 77,540 National Forest System acres of riparian vegetation and associated corridor vegetation occur within the assessment area. Table 10 indicates that riparian areas[11] are a limited component on the landscape, approximately 3 percent [12] of the montane units and 1 percent of the pine savanna units.

---

[11] Includes the local classifications Riparian-Graminoid, Riparian Cottonwood, Riparian-Aspen, Riparian-Green Ash, Riparian-Shrub, and Riparian-Corridor

[12] This is likely a slight under-representation of montane riparian vegetation as there are some data gaps in the central portion of the Madison, Henry's, Gallatin, Absaroka and Beartooth Mountain Landscape Area.

Table 10. Riparian vegetation and associated corridor vegetation acreage by ownership within the proclaimed boundary of the Custer Gallatin National Forest

Landscape Area	Non-NFS Ac	Non-NFS Riparian Ac	Non NFS Riparian %	NFS Ac	NFS Riparian Ac	NFS Riparian %	Grand Total Ac All Owners	Grand Total Riparian Ac	% Riparian All Owners
Montane Units									
Bridger, Bangtail, Crazy Mtns	116676	3234	3%	205025	5465	3%	321701	8699	3%
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	184889	11529	6%	2158640	67695	3%	2343529	79224	3%
Pryor Mtn	2877	254	9%	75067	2278	3%	77944	2532	3%
Subtotal	304443	15017	5%	2438731	75438	3%	2743174	90455	3%
Pine Savanna Units									
Sioux	14165	221	2%	164460	1259	1%	178625	1480	1%
Ashland	65463	1683	3%	436133	843	<1%	501596	2526	1%
Subtotal	79628	1904	2%	600593	2102	<1%	680221	4006	1%
Grand Total	384071	16921	4%	3039324	77540	3%	3423395	94461	3%

Cover types within the riparian and wetland areas include riparian graminoid (grass and grass-like; approximately 19,700 acres), riparian deciduous tree (cottonwood, aspen, green ash; approximately 7,900 acres), and riparian shrub types (approximately 2,400 acres). Of these types, the riparian graminoid category is the most common and is especially prevalent in the montane units. Within the Custer Gallatin National Forest, there are over 17,700 acres of water bodies (approximately 17,700 montane and approximately 20 pine savanna) classified as river or riverine systems and over 4,600 acres of water bodies (4,400 montane and 200 pine savanna) classified as freshwater pond or lakes.

Lifeform and Cover Types

Riparian areas are rare ecosystem components. The composition and condition of riparian vegetation along stream banks and adjacent riparian areas provides critical information on the stability and resiliency of the riparian system and the condition of associated aquatic and riparian habitat. Improving riparian vegetation is, more often than not, the key or first step towards improving channel and habitat conditions, particularly along streams that aren't armored by rock and/or large wood.

Riparian in the montane units consists predominantly of riparian graminoid (grass-like) cover types (i.e. wet meadows) and aspen cover types. Riparian in the Bridger, Bangtail, and Crazy landscape area and the Madison, Henry's, Gallatin, Absaroka, and Beartooth landscape area also have the same predominant cover types as the overall Montane Unit. The Pryor landscape area, however, consists predominantly of riparian shrubland (i.e. willows, birch) and riparian graminoid (sedges/rushes) dominance types. The Ashland and Sioux landscape areas consists predominantly of riparian green ash and graminoids with a minor amount in shrubs. Table 11 and Table 12, and Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6, and Figure 7 display these findings.

Table 11. Montane units – acres of riparian vegetation cover types by ownership

Montane Units – Riparian Cover Types	Non-NFS Land Acres	NFS Land Acres
Bridger, Bangtail, Crazy Mtns	1474	2036
Riparian-Aspen	680	924
Riparian-Cottonwood	9	7
Riparian-Graminoid	498	767
Riparian-Shrub	287	338
Madison, Henrys Lake, Gallatin, Absaroka and Beartooth Mtns	4867	25466
Riparian-Aspen	1329	4932
Riparian-Cottonwood	510	318
Riparian-Graminoid	2515	18393
Riparian-Shrub	514	1823
Pryor Mtn	140	163
Riparian-Aspen	10	40
Riparian-Cottonwood	0	2
Riparian-Graminoid	18	11
Riparian-Shrub	112	109
Grand Total	6481	27665

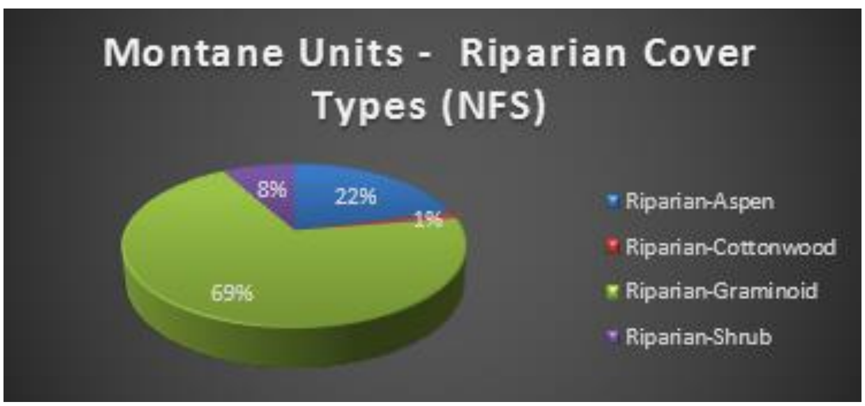

Figure 1. Riparian cover types – montane units (National Forest System)

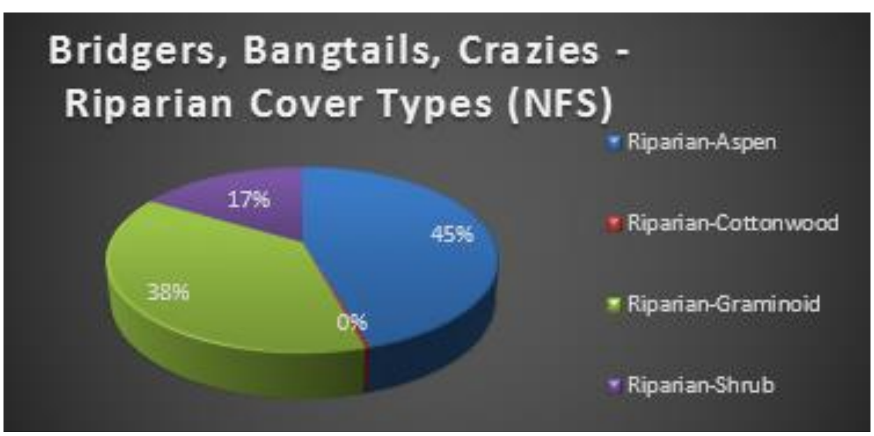

Figure 2. Riparian cover types – Bridger, Bangtail, Crazy Mountains (National Forest System)

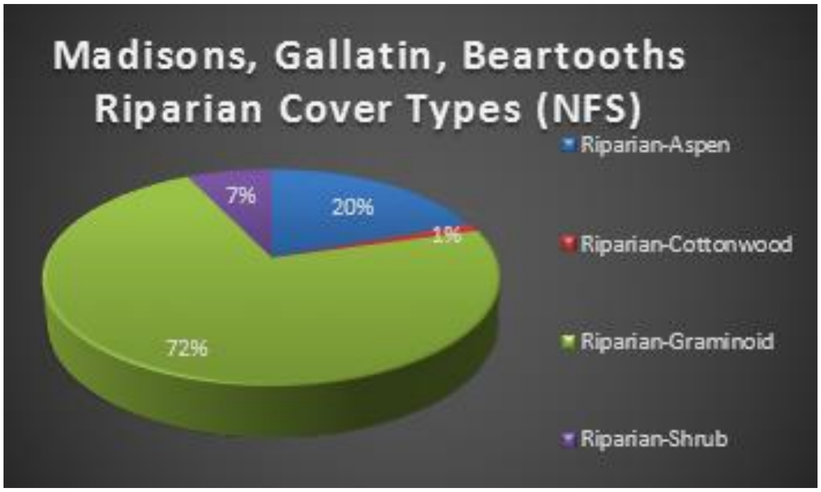

Figure 3. Riparian cover types – Madison, Henry's, Gallatin, Absaroka and Beartooth Mountains (National Forest System)

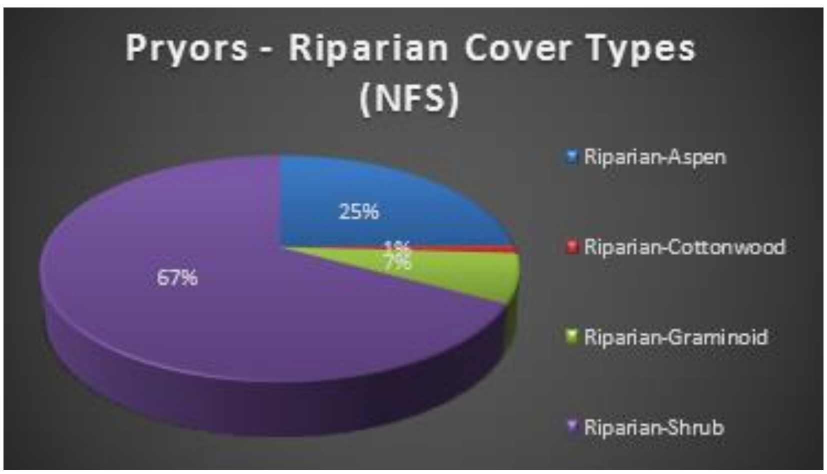

Figure 4. Riparian cover types – Pryor Mountains (National Forest System)

Table 12. Pine savanna units – acres of riparian vegetation cover types by ownership

Pine Savanna Units - Riparian Cover Types	Acres Non-NFS Lands	Acres NFS Lands
Ashland	1683	843
Riparian-Graminoid	37	38
Riparian-Green Ash Woodland	1434	732
Riparian-Shrub	212	73
Sioux	221	1259
Riparian-Graminoid	101	458
Riparian-Green Ash Woodland	116	744
Riparian-Shrub	5	56
Grand Total	1904	2101

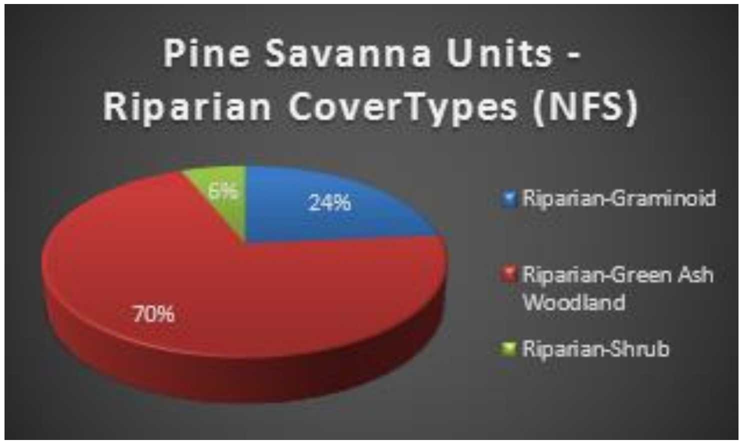

Figure 5. Pine savanna units – riparian cover types

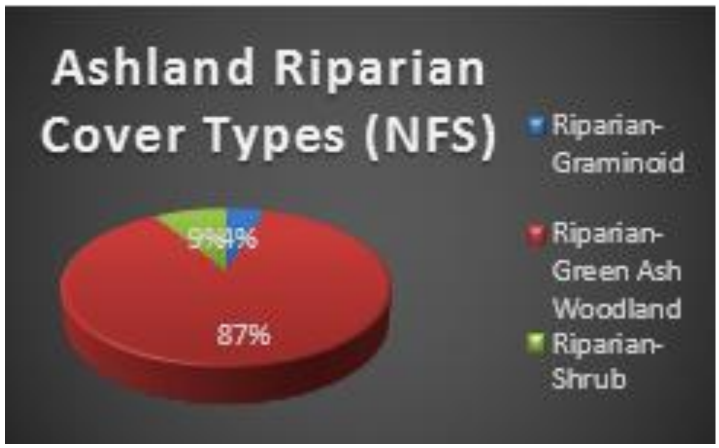

Figure 6. Riparian cover types - Ashland

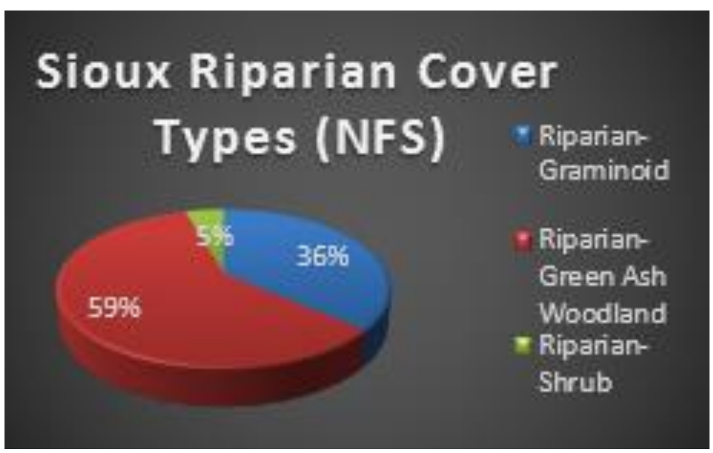

Figure 7. Riparian cover types - Sioux

Lentic riparian types (associated with standing water) are found sporadically in seeps and ponds with associated physical characteristics and riparian vegetation that absorbs peak flows during flood events, recharge water slowly into underground aquifers, and improve water quality by filtering excess nutrients, breaking down chemical and organic wastes and by trapping sediments (Hansen, 1995).

Lotic riparian types are associated with perennial systems provide attributes that are important for dissipating stream energy associated with high waterflow, thereby reducing erosion. Intermittent stream characteristics can help filter sediment, capture bedload, and aid floodplain development. They can improve floodwater retention and ground water recharge. Some attributes of these systems can develop root masses that stabilize streambanks against cutting action (Prichard, 1998).

Both of these riparian types are widely distributed across the Forest. At the 1:24,000 scale, the Custer Gallatin National Forest contains 3,341 lakes and ponds (22,148 acres), with many more unmapped lentic features (seeps, smaller ponds). Over 5,700 miles of stream are present on the Custer Gallatin (1:100,000 scale), with greater than 4,300 miles being intermittent or perennial channel likely to express development of riparian vegetation. As mapping accuracy improves at finer scales, the latter number will increase.

Three general flow regimes characterize Custer Gallatin National Forest stream systems: ephemeral, intermittent, and perennial, representing the reliability of surface stream flow within a stream reach. Flow, in turn, strongly influences development and expression of riparian vegetation (Cooper and Merritt 2012). Ephemeral streams are typically wetted during snowmelt or rain events, and dry at other times, which generally limits the development of riparian vegetation. Perennial streams are typically flowing year-round, and typically have well-developed riparian zones. Intermittent streams exhibit a mix of residual pools and dry reaches within a year, or during drier periods, and fully wetted channels during other times of the year, or during wetter years. Development and expression of riparian vegetation can naturally vary widely within intermittent streams, depending upon the frequency and duration of surface flow, as well as the stream channel's connection with the adjacent water table (Cooper and Merritt 2012).

The general conceptual expression of these flow regimes across the landscapes is ephemeral flows in watershed headwater first order channels, followed by intermittent channels as flow and floodplain alluvium concentrates, and culminated by perennial flow in downstream reaches. In montane settings, flow regimes often transition directly from ephemeral to perennial flow, because more flow is available. Exceptions to these general patterns exist in both montane and Pine Savanna settings on the Forest: some channels begin with perennial flow at headwater springs and either retain flow throughout, or later transition to intermittent channels.

Of the more than 5,700 miles of mapped stream channel on the Custer Gallatin National Forest, 1,351 miles (24 percent) are considered ephemeral; about 57 percent of this amount is present on the pine savanna landscape, representing 63 percent of mapped channel. Conversely, ephemeral channels represent about 13 percent of montane streams. A similar pattern holds for intermittent streams, as 33 percent of pine savanna streams, but less than 1 percent of montane, are intermittent. Finally, 4 percent of pine savanna streams are perennial, as compared to 84 percent of montane.

Condition

Elmore and Beschta (1987) suggest that many factors can result in adverse changes to riparian areas: changing climatic and precipitation patterns, more frequent flooding, altered beaver populations, improper streamside grazing, improper use of upland watersheds, road construction, and others.

Livestock grazing is unquestionably a significant factor. Since grazing is intrinsically associated with the challenges, its management is also fundamentally important in the solutions.

Currently, riparian vegetation within primary rangelands for permitted livestock grazing is approximately 3 percent of the riparian vegetation found in the montane units and 86 percent of the riparian vegetation found in the pine savanna units. Riparian vegetation within primary rangelands for permitted livestock grazing is approximately 5 percent of the riparian vegetation found in the overall assessment area as displayed in the following table.

Table 13. Total National Forest System primary rangeland and amount of riparian vegetation within primary rangeland vegetation

Landscape Area	NFS Primary Rangeland NFS Acres	Total NFS Acres	% of Total NFS that is Primary Rangeland	NFS Riparian Vegetation Acres[13]	NFS Riparian Acres found within Primary Rangeland	% of CGNF Riparian Vegetation that is in Primary Rangeland
Montane Units						
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	73472	2158640	3%	5465	933	17%
Bridger, Bangtail, Crazy Mtns	40185	205025	20%	67695	1728	3%
Pryor Mtns	24383	75067	32%	2278	54	2%
Montane Subtotal	138040	2438732	6%	75438	2116	3%
Pine Savanna Units						
Ashland	367386	436133	84%	843	698	83%
Sioux	143320	164460	87%	1259	1119	89%
Pine Savanna Subtotal	510706	600593	85%	2102	1817	86%
Grand Total	648746	3039324	21%	77540	3933	5%

Some level of allotment management planning has been completed on nearly all of the 234 active and vacant allotments on the Custer Gallatin National Forest. Currently, the 22 allotments (15 active and 7 vacant) that have not had National Environmental Policy Act analysis conducted have been scheduled for revision over the next ten years. This leaves a small amount of primary rangeland acres for interdisciplinary review, analysis, and decisions to move vegetation, including riparian, in desired directions of improving conditions. Prescribed use levels, reduced grazing durations, and stocking rate reductions implemented through these National Environmental Policy Act decisions provides mitigation to move toward desired conditions.

Within the primary rangelands permitted for grazing in the overall assessment area, 71 percent of the riparian survey sites were found to be in proper functioning condition, with 27 percent functioning at risk and 2 percent were rated as non-functional. Within the montane units, 72 percent of the survey sites were found to be in proper functioning condition, with 25 percent functioning at risk and 3 percent were rated as non-functional. Within the pine savanna units, 58 percent of the survey sites were found

[13] Includes modelled riparian corridor dominated by more coniferous tree species.

to be in proper functioning condition, with 42 percent functioning at risk and none were rated as non-functional. See Permitted Grazing Report for detailed information.

Of 273 watershed condition framework-rated watersheds forestwide, 47 (17 percent) were functioning at risk, with the remainder rated as functioning properly. Of functioning at risk watersheds, 15 (32 percent) were on pine savanna districts and 32 (68 percent) were on the montane districts. Nineteen percent of the watersheds related to only the riparian vegetation condition indicator are rated as functioning at risk, with the remainder rated as functioning properly. Results are strikingly different for the pine savanna units, where 49 percent of watersheds had reduced riparian vegetation condition, compared to 6 percent of montane watersheds. See Aquatics and Riparian Report for further detail.

Grasslands / Shrublands

Background

A variety of grasslands are associated moist (mesic) and drier (xeric) shrublands in varying patterns across the landscape. Mesic shrublands are often associated with coniferous forests and occur as large landscape patches on moister sites (e.g., northeast facing slopes) or in smaller patches in grasslands. Because of the moisture regime, these shrublands can be very productive and therefore favored by wildlife.

Grasslands occur mostly on areas too dry to support trees, although a few are found on soils at mid to high elevations that are too wet during the growing season for tree growth. In the forest zone between the upper and lower timberline, areas dominated by shrubs, forbs and grasses typically include one or more of the following characteristics: convex or well-drained landforms, thin or poorly developed soils that usually are quite dry, and high winds. Fires or landslides open up the forests in some areas, allowing early successional herbaceous and shrubby stages to flourish for a time. Above treeline in the alpine zone, the climate is too severe for trees. Grass cover type is estimated to be about 11 to 32 percent of the montane units and 45 to 65 percent of the pine savanna units using Region 1 existing vegetation database data.

Shrublands have deeper, more developed soils and more available moisture. In the montane units, shrublands are mostly dominated by mountain big sagebrush (*Artemisia tridentata vaseyana*) with some lower elevations dominated by Wyoming big sagebrush (*Artemisia tridentata wyomingensis*. Bitterbrush (*Purshia tridentata*) is found on the Hebgen Lake unit on mid to lower slope positions of south and west-facing exposures. Shrubby cinquefoil is found in moist sagebrush communities and occasionally on the fringes of wet or moist meadows at higher elevations. Willow-dominated shrublands (*Salix* spp.) are common in riparian areas and wet meadows. In the pine savanna units, shrublands are mostly dominated by Wyoming big sagebrush (*Artemisia tridentata wyomingensis*). Common shrubs in draws and along streams include buffaloberry, chokecherry, snowberry, and silver sagebrush.

The following table summarize amounts of grassland / shrubland vegetation by cover type groups.

Table 14. National Forest System acreage of grasslands and shrublands by landscape area, VMap 2015

Landscape Area	Dry Grass	Wet Grass	Dry Shrub	Mesic Shrub
Montane Units				
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	254891	25263	31226	11645
Bridger, Bangtail, Crazy Mtns	21669	1287	904	609
Pryor Mtns	23881	108	765	551
Montane Subtotal	300441	26658	32895	12805
Pine Savanna Units				
Ashland	196627	1058	10038	5274
Sioux	104695	968	842	4750
Pine Savanna Subtotal	301322	2026	10880	10024

Mountain big sagebrush generally occupies open dry sites at elevations below montane forests where winters are cold and dry, spring and early summer months receive most precipitation, and drier conditions are expected from mid-summer through the fall (Welch 2005). Sagebrush steppe vegetation, dominated by mountain big sagebrush, is also characterized by the presence of native forbs and cool season perennial bunch grasses (for example, *Agropyron, Festuca, Koeleria, Poa, Stipa*). Wyoming big sagebrush generally occupies open dry sites in the pine savanna units. Throughout the range of this association, the vegetation consists of an open to moderately dense shrub layer (about 10 to 25 percent canopy cover) dominated by *Artemisia tridentata* ssp. *wyomingensis*, and a herbaceous layer dominated by bluebunch wheatgrass with lesser amounts of Sandberg bluegrass (sometimes a codominant grass). Other shrubs (especially rabbitbrush species) and herbaceous species (especially needle and thread grass) can be present.

A minor cause of sagebrush mortality[14] is winter injury. This occurs when temperatures drop quickly below freezing before plants have entered dormancy, or when a warm spell promotes winter growth followed by a return to typical winter temperatures. Extended periods of winter and summer drought (normally more than 2 years) can also cause dehydration and death (Tilley et. al., 2006).

Sagebrush steppe vegetation on the Custer Gallatin National Forest has high levels of native plant species diversity and provides essential habitat requirements for many wildlife species, such as pronghorn antelope and greater sage-grouse, while also providing valuable grazing land for livestock.

Montana, North and South Dakota, Wyoming, Utah, Oregon, Nevada, and Idaho, are the strongholds for sage-grouse across their range and have been the focus of recent petitions to list the species under the federal Endangered Species Act. Among the primary threats for sage-grouse are loss and fragmentation of their habitat. The species' sagebrush habitat components are important for this species persistence (USFWS, 2013). Because of this habitat concern, core (priority) areas are priorities for habitat protection

[14] Another agent of sagebrush mortality mostly reported in the Great Basin and Oregon is from the aroga moth.

and/or restoration. Locations are shown in

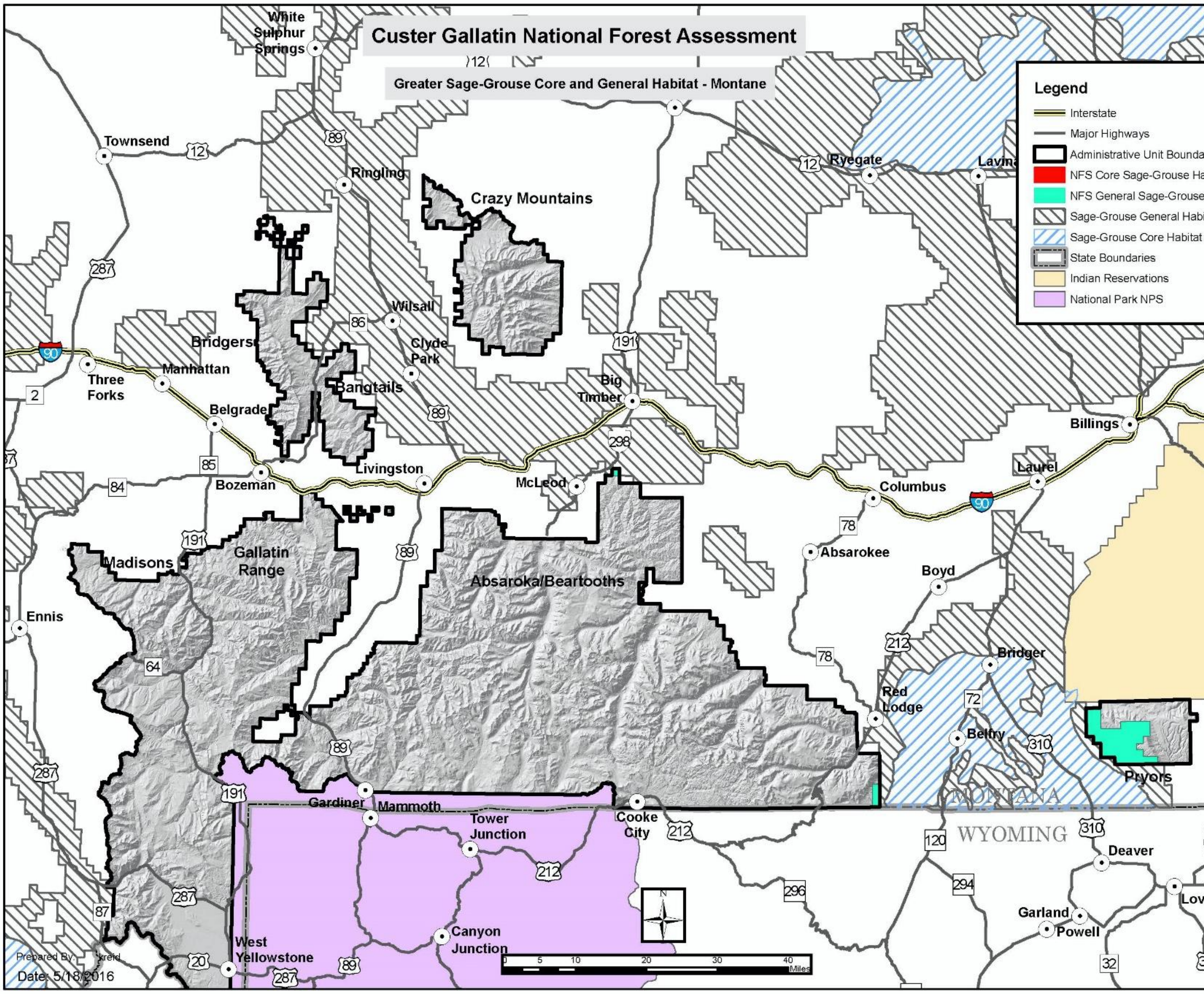

Figure 8 and Figure 9 for the montane and pine savanna ecosystems.

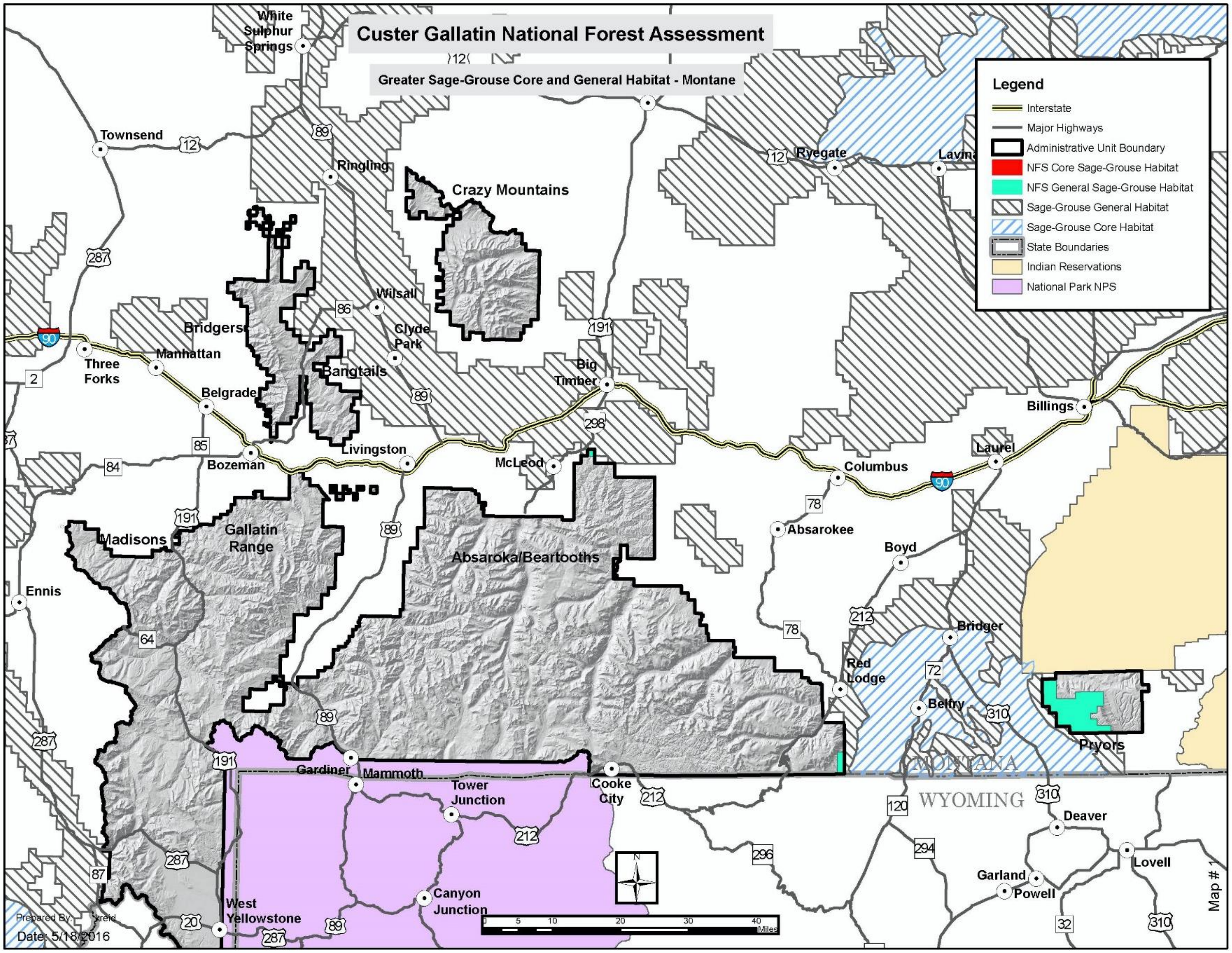

Figure 8. Greater sage-grouse core/priority (red) and general habitat (cyan blue) – montane

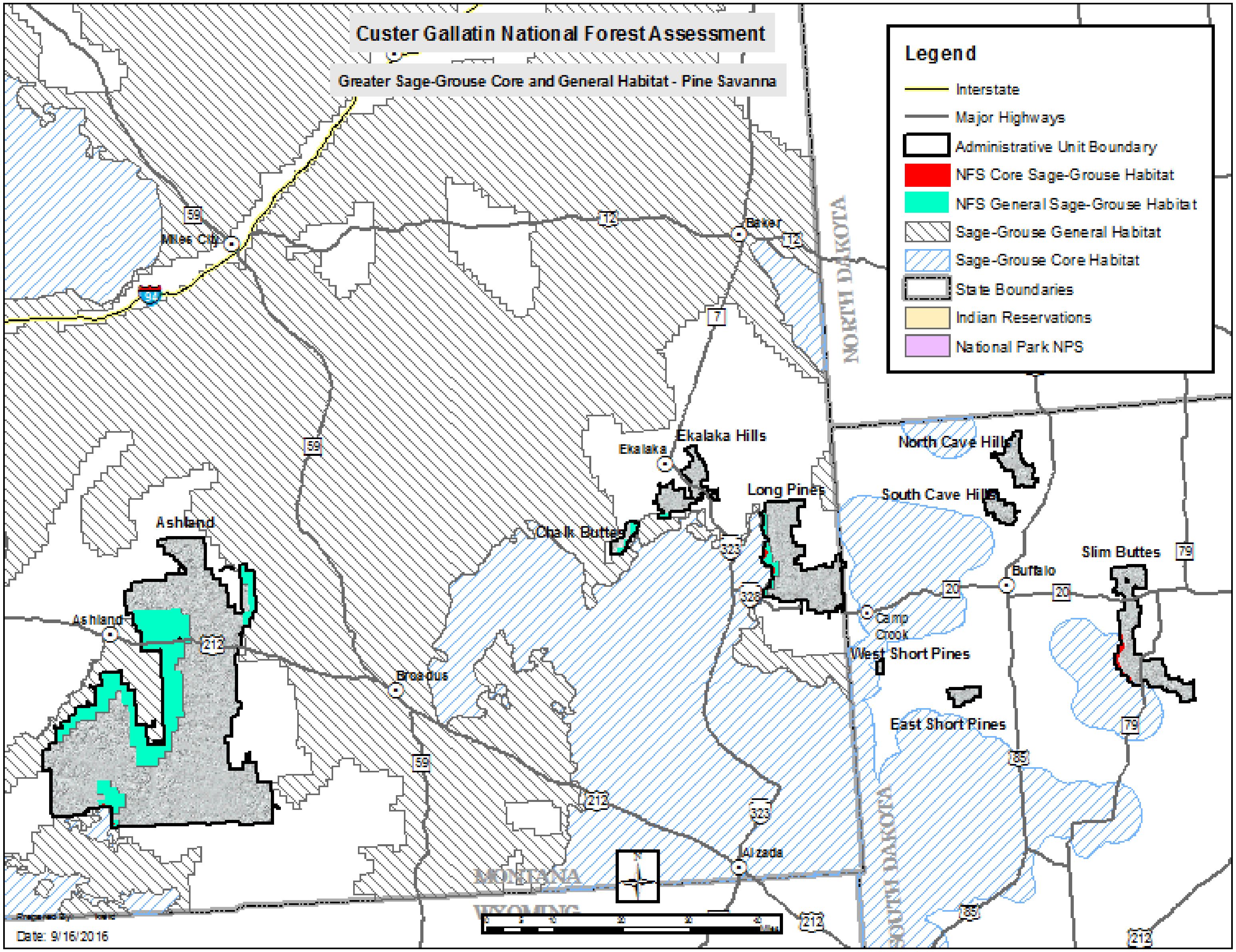

Figure 9. Greater sage-grouse core/priority (red) and general habitat (cyan blue) – pine savanna

Table 15 outlines the amount of greater sage-grouse core and general habitat by landscape area.

Table 15. Acreage of greater sage-grouse habitat by landscape area

Landscape Area	Core Habitat[15]	General Habitat[16]	Grand Total
Montane Units			
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns.		2776	2776
Bridger, Bangtail, Crazy Mtns		4	4
Pryor Mtns		27392	27392
Montane Subtotal	0	30172	30172
Pine Savanna Units			
Ashland	336	101290	101626
Sioux	1868	8424	10292
Pine Savanna Subtotal	2204	109714	111918
Grand Total	2204	139886	142090

Of the approximate 2,200 acres of core habitat found within the assessment area, about 100 percent of the acreage is within grazing allotments on the Sioux Ranger District. Of the approximate 123,400 acres of the general habitat, about 88 percent of the acreage is found within grazing allotments. Table 16 outlines the amount of greater sage-grouse habitat found within grazing allotments by landscape area. Specific allotment acreages are outlined in the "Permitted Grazing" section of the assessment.

Table 16. Acreage of greater sage-grouse habitat within permitted grazing allotments

Allotment #	Core Habitat	General Habitat	Grand Total
Montane Units			
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns		520	520
Bridger, Bangtail, Crazy Mtns		2	2
Pryor Mtns		22152	22152
Montane Subtotal	0	22674	22674
Pine Savanna Units			
Ashland	336	92479	92815
Sioux	1868	8214	10082
Pine Savanna Subtotal	2204	100693	102897
Grand Total	2204	123367	125571

[15] Per MT Fish, Wildlife, and Parks GIS metadata, Sage-grouse core areas are habitats associated with 1) highest densities of sage-grouse, based on male counts and/or 2) sage-grouse lek complexes and associated habitat important to sage-grouse distribution.

[16] General habitat are areas with or without on-going or imminent impacts containing sage-grouse habitat outside of the priority core areas. Management actions would maintain habitat for sustainable sage-grouse populations to promote movement and genetic diversity. Areas are delineated based on sage-grouse habitat.

About 6 percent of core habitat (less than 100 acres) and about 2 percent of general habitat (less than 3,400 acres) is infested with invasive plant species. Table 17 outlines the amount of greater sage-grouse habitat infested by invasive plant species.

Table 17. Acreage of invasive species found within greater sage-grouse habitat

Landscape Area	Core Habitat	General Habitat	Grand Total
Montane Units			
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns		201	201
Pryors		70	70
Montane Subtotal	0	271	271
Pine Savanna Units			
Ashland		3058	3058
Sioux	96	28	123
Pine Savanna Subtotal	96	3086	3181
Grand Total	96	3357	3452

Condition

Grassland and sagebrush communities were a focal point in terms of forage required in order to support large ungulates which inhabited the area prior to settlement times. These large ungulates had an effect on plant development and successional patterns which occurred across the landscape within these vegetative communities. Processes such as grazing, trampling, and nutrient recycling served to diversify the vegetation composition and seral stages. Many seral stages occur within the estimated 50 grassland/shrubland habitat types (Stewart and Mueggler, 1978; Hansen and Hoffman, 1988) that occur on the Custer Gallatin National Forest.

Mountain big sagebrush, located on the montane units, is easily killed by fire and often requires in excess of 10 to 35 years or longer (Baker, 2006) to reestablish to pre-burn stature and density. Wyoming big sagebrush is located predominantly on the Sioux and Ashland Districts with minor amounts on the Beartooth. This species may require in excess of 100 years to reestablish to pre-burn stature and density (Baker, 2006).

The approximate 2,200 acres of core sage-grouse habitat is found along the lower elevation fringes on the Sioux District. Three hundred and sixty-four acres (16 percent) have experienced recent low severity wildfire effects which can create small amounts of Wyoming big sagebrush mortality compared to moderate or high burn severities. Of the approximate 123,400 acres of the general sage-grouse habitat found in the assessment area, approximately 13,800 acres (11 percent of the general habitat) have experienced moderate to high mortality of Wyoming big sagebrush due to a recent mix of moderate and high severity wildfire effects. The recovery rate to pre-fire densities will be slow as discussed above. In the montane units, a minor amount of mountain big sagebrush mortality occurred in recent fires. Recovery projections are expected to be faster than burned Wyoming big sagebrush of the Ashland and Sioux Districts as discussed above. Table 18 displays the amount of core (priority) and general Greater Sage-grouse habitat by wildfire burn severity.

Table 18. Amount of core (priority) and general greater sage-grouse habitat by wildfire burn severity (acres)

Landscape Area	Burn Severity in Core (Priority) Habitat	Burn Severity in General Habitat			Grand Total
	Low	Low	Moderate	High	
Ashland		17046	10578	2459	30083
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns		142	112	51	305
Pryors		35	18	25	78
Sioux	364	1423	574	162	2524
Grand Total	364	18647	11282	2698	32991

The existing condition of grassland/shrublands varies across the landscape. In general, they have shown improvement over time with the advent of cross-fencing to move most units from season long to rotation grazing, installing offsite water developments (away from riparian and hardwood draw areas), having improved range readiness entry dates, and shorter duration grazing with more opportunity for plant recovery. This is not to discount that there continues to be some areas where issues are still being assessed and managed. Detailed information for allotment conditions are found in the Permitted Grazing Report.

Juniper and Limber Pine Woodlands'

Background

Evergreen woodlands in xeric settings include juniper and limber pine. Table 19 displays acreage of each type.

Table 19. National Forest System acreage of juniper and limber pine woodlands by landscape area, VMap 2015

Landscape Area	Juniper	Limber Pine
Montane Units		
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	1492	35
Bridger, Bangtail, Crazy Mtns	32	288
Pryor Mtns	4273	Present
Montane Subtotal	5797	423
Pine Savanna Units		
Ashland	Present	
Sioux	Present	
Pine Savanna Subtotal	Present	

Condition

Rocky Mountain and Utah Juniper communities appears to be stable (MTNHP, 2016). Utah juniper is known in the Pryor Mountains on the northern extent of its range. Limber pine (*Pinus flexilis*) in the assessment area has reduced abundance due to exotic white-pine blister rust infections, native mountain pine beetle outbreaks, and continued fire exclusion.

Rocky Mountain Juniper (*Juniperus scopulorum*) and Utah Juniper (*Juniperus osteosperma*)

Rocky Mountain juniper occurs on the lower slopes across the entire assessment area. The northern extent of Utah juniper occurs in the Pryor Mountains and as such, often has a shorter or stunted growth form. Some are as old as 500 years old. The lower slopes of the Big Pryor Mountain (4,900 to 5,900 feet) are dominated by Utah juniper, with Rocky Mountain juniper and limber pine scattered along the north-facing slopes. Utah juniper yields to Rocky Mountain juniper and limber pine between 5,900 and 6,500 feet. Southern lower slopes of East Pryor Mountain (less than 5,400 feet) are vegetated by Utah juniper and mixed with Rocky Mountain juniper and mountain mahogany woodlands (Knight et al., 1987).

Limber Pine (Pinus flexilis)

Limber pine is a slow growing, long-lived species, sometimes taking several hundred years to reach maturity. Mature trees may exceed 1000 years of age. Limber pine stands are broadly even-aged, though populations also occur in uneven-aged stands and on very harsh sites as widely spaced, isolated individuals. Trees often have an irregular or multi-stem growth form, and rarely reach over 50 feet. The species is cold and drought tolerant. Trees are ectomycorrhizal, have deep taproots, and are very windfirm. In Montana, limber pine is generally known from 4,000 to 6,000 feet. Limber pine reproduces entirely from seed. Seeds are not effectively dispersed by wind. Small mammals and birds, especially Clark's nutcrackers and pinyon jays, disperse limber pine seeds. The minimum seed-bearing age of limber pine ranges from 20 to 40 years. Clark's nutcrackers have co-adapted an important mutualism with limber pine and are the primary harvester and disperser of its seeds. Limber pine regeneration on burns is largely from germinants of Clark's nutcrackers seed caches[17] (FEIS Database, 2016).

Limber pine is susceptible to white pine blister rust, caused by a fungus that was introduced accidentally from Europe. Limber pine mortality is high in many areas throughout its range, including portions of the Custer Gallatin National Forest.

Wildfires are less frequent in limber pine communities than in other conifer habitats because of limited productivity and fuel accumulation associated with poor soil development, short growing seasons, and late snowmelt (FEIS, 2016).

Green Ash Woodlands’

Background

Green ash woodlands are known only from the Ashland and Sioux Ranger Districts. Table 20 displays acreage by unit. Ashland area green ash woodlands are on the eastern edge of its range.

---

[17] Distinguishing limber pine from the related whitebark pine (*Pinus albicaulis*), can only easily be done by the cones. Where the species overlap, in limber pine, the cones are 2.4 to 4.7 inches long, green cones when immature, and open to release the seeds; the scales are not fragile. In whitebark pine, the cones are 1.6 to 2.8 inches long, dark purple cones when immature, and do not open on drying, but are fragile and are pulled apart by birds to release the seeds. A useful clue is that whitebark pines almost never have intact old cones lying under them, whereas limber pines usually do.

Table 20. National Forest System acreage of deciduous broadleaf woodlands by landscape area, VMap 2015

Landscape Area	Green Ash
Pine Savanna Units	
Ashland	1378
Sioux [18]	10046
Total	11424

Green Ash Woodlands (*Fraxinus pennsylvanica*)

Green ash woodlands were common prior to European settlement. Early explorers and settlers reported the occurrence of green ash draws in eastern Montana and the adjacent Dakotas. Granville Stuart, an early cattle rancher, described the country along Rosebud Creek and the Tongue River in 1880 as having “plenty of big scrubby ash trees along the dry creeks and bluffs” and “small groves of ash and boxelder in ravines and along little creeks” (Lesica and Marlow, 2013).

In the Northern Great Plains, green ash woodlands are important in the overall landscape mosaic, even though they represent a very small fraction of the total area. Locally, on the Sioux and Ashland Districts, these areas are known as woody draws, hardwood draws, or green ash woodlands. Green ash and chokecherry are the typical dominants with sporadic inclusion of boxelder. On the Sioux and Ashland Districts, woody draw communities are composed mostly of small trees, although larger diameter trees can occur at the foot of the ravine where there is greater available soil moisture. It is estimated that green ash woodlands constitutes less than one percent of the Ashland and Sioux Districts. Although this represents a very small portion of the districts, the ecological values associated with them are very important for biological diversity. Located in areas of greater than normal moisture, they are more productive than the surrounding steppe vegetation. Green ash woodlands also attract wildlife and livestock for thermal cover, nesting habitat, moisture, browse, and hiding cover. Because of this, these woodlands are focal points for some of the livestock and wildlife management in the region.

Green ash woodlands are important elements of elk, mule and white-tailed deer, sharp-tailed grouse, wild turkeys, coyotes, weasel, red fox, bobcats, deer mice, squirrels, and many non-game birds including neotropical migrants. The ovenbird requires dense ground cover and leaf litter. Several raptors use these settings and they include great-horned owl, long-eared owl, Swainson’s hawk, and red-tailed hawk. Heavy sedge (*Carex gravida* var. *gravida*), although not globally rare, is a Northern Region Forest Service sensitive species and known from only a handful of green ash woodland sites on the Ashland and Sioux Districts.

Hardwood draws can be classified into two groups on the Ashland and Sioux Districts: Hardwood draws in higher gradient, constricted valley bottoms or V-shaped ravines (most often ephemeral and intermittent streams); and riparian with interspersed hardwood clusters in lower gradient, wider valley bottoms (ephemeral, intermittent, or perennial stream segments).

In many cases, these areas do not meet the strict definition of a wetland or riparian because water may not be present long enough each year to create anaerobic soil conditions. Nevertheless, they clearly

[18] Vmap originally depicted 421 acres of cottonwood and 88 acres of aspen for the Sioux RD. However, it is highly likely that most of the cottonwood acreage is really aspen. Cottonwood is a very minor component on the District. Combining the acreages for 509 acres of aspen and presence of cottonwood on the Sioux RD is more representative (Buchanan, 2016. Pers. Comm.).

perform some of the functions of riparian areas. Like riparian areas, their importance and rareness in the landscape makes them among the most valuable resources.

Green ash woodlands are best developed under conditions that favor snow entrapment, development of deeper soils, and concentration of moisture. These conditions are typical of ravines formed by ephemeral and intermittent streams where flooding is more sporadic or of short duration. Uplands are generally mixed grass pine savannas, shrublands and ponderosa pine forest. Soils are usually deep loams. Flooding is very short in duration when it occurs, as water is rapidly channeled downslope. Water tables are generally near the soil surface in spring or after storm events, but commonly fall below 39 inches during dry periods (Hansen et al., 1995). The dominant shrub in the associated habitat type is chokecherry. This species is intolerant of prolonged flooding or poor drainage underscoring the infrequency of flooding in the green ash/chokecherry habitat type (FEIS, 2013).

The establishment and survival of hardwoods is closely linked to topography and usually restricted to areas of increased moisture, which helps explain their limited distribution in semi-arid climate (Girard et al., 1989, p. 2). Due to a semi-arid climate, hardwood stands are restricted to areas of increased moisture such as along drainage-ways, streams, springs, floodplains, and north-facing slopes. A number of factors, in addition to topography and climate, influence the hardwood draws such as microenvironment, fire, moisture regimes, wildlife, livestock, and disease and insects (Girard, 1985. p.1).

While soil moisture has been described as important, too much soil moisture and lack of soil aeration may be more influential in some situations of low gradient Pine Savanna streams. Aeration limits tree root penetration that in turn limits water and nutrient absorption (Girard, 1989). This may be an explanation for the lack of extensive hardwood stands along riparian wetlands in wider valley bottoms of lower gradient streams.

According to Lesica and Marlow (2013), green ash have male and female flowers on separate plants. Female flowers and young fruits are very sensitive to late spring frosts. Its seed bank is short-lived. Seedlings grow equally well in sun or shade, but are intolerant of saline soil conditions. Seedlings can survive for 1-2 years in competition with dense herbaceous cover, but growth is greatly curtailed resulting in lowered seedling survival. In addition, green ash readily sprouts from the root crown, allowing it to rejuvenate if mature trunks are lost. Crown sprouts are capable of regenerating a canopy-size in approximately 20 years. Recruitment from seed is curtailed by competition with grass. A maximum age of approximately 100 years has been reported in the region. These estimates are for above-ground trunks and do not take recruitment from stump sprouts into account. Life expectancy for individual root systems is not known. Crown die-back is often attributed to disease, drought and freeze injury.

The species is on the western and most arid margin of its range in eastern Montana and is likely at the limit of its environmental tolerances. Because of this, extended periods of drought may have an adverse effect on regeneration and probably promote other problems.

Generally, the area has had a riparian and hardwood draw disturbance history from grazing since the turn of the century, drought, insect and disease damage, and wildfire. Until recently, there have been fewer large wildfire disturbances due to fire suppression activity since settlement times.

Green ash is very susceptible to white stringy heartrot fungus in the north western portion of its range. Heartrot rarely kills it host tree, but infected trunks and branches are weakened and more susceptible to breakage by wind or ice. In eastern Montana, an average of 38% of ash trees displayed heartrot. Heartrot is more common in arid climates, suggesting that it may contribute to the decline of ash woodlands where drought stress is common. Insect pests include ash bark beetles, larvae of the black-headed sawfly and the non-native emerald ash borer that can kill trees in one to three years (Lesica and Marlow, 2012).

About 8,900 acres (National Forest System) of green ash woodlands occurs on the Ashland and Sioux Districts. Table 21 and Figure 10, Figure 11 and Figure 12 display the amounts and types of green ash cover types found on the Ashland and Sioux Districts.

Table 21. Pine savanna units – green ash cover types

Pine Savanna Units - Green Ash Cover Types	Non-NFS Land Acres	NFS Land Acres
Ashland		
Broadleaf Savanna	589	240
Broadleaf Woodland	378	264
Mixed Forest	16	89
Mixed Savanna	10	78
Ashland Subtotal	993	671
Sioux		
Broadleaf Savanna	142	2355
Broadleaf Woodland	232	4491
Mixed Forest	20	1363
Mixed Savanna	1	52
Sioux Subtotal	395	8261
Grand Total	1389	8931

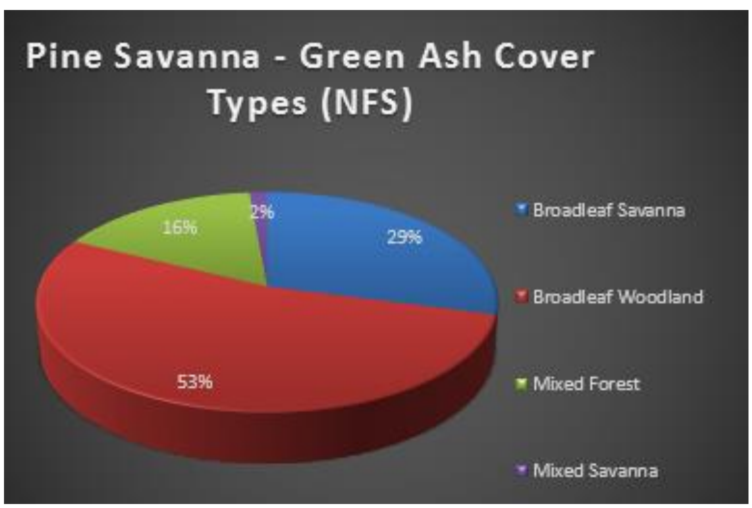

Figure 10. Green ash cover types – pine savanna units (National Forest System)

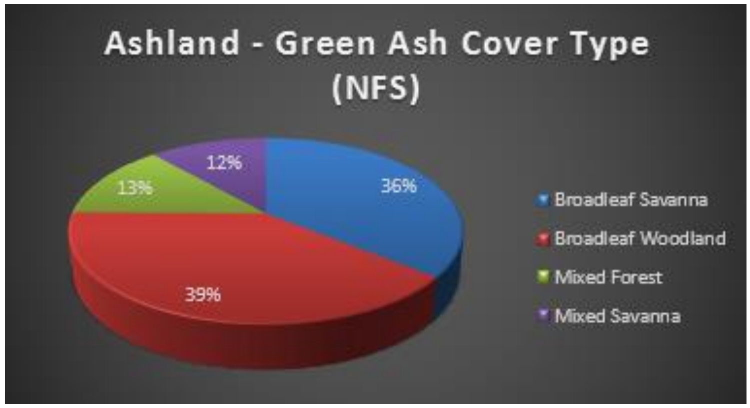

Figure 11. Green ash cover types – Ashland (National Forest System)

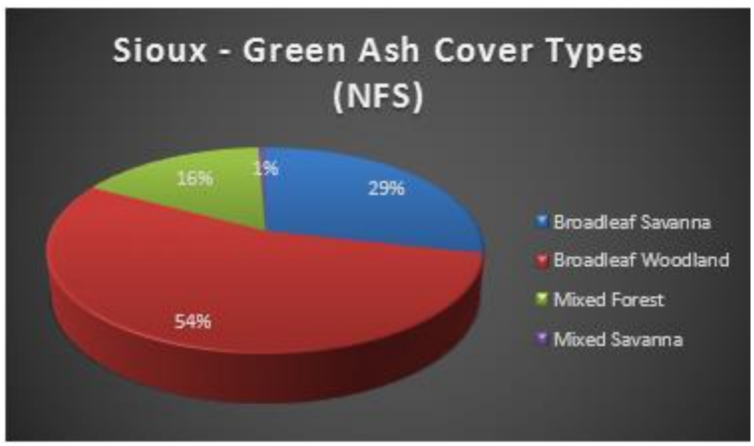

Figure 12. Green ash cover types – Sioux (National Forest System)

Green ash is a shade-intolerant species that reproduces both through seed production and vegetative sprouting. Habitats dominated by green ash woodlands are rare in the pine savanna units of the assessment area. This species also occurs as a component in dry ponderosa pine forests and as open, savannah trees in non-forested areas.

Condition

Evidence from studies throughout the Northern Great Plains between 1978 and the present suggest that the majority of green ash woodlands have declined (Lesica and Marlow, 2013). Many of those in eastern Montana and the adjacent Dakotas are relatively open with few young trees and understories dominated by snowberry, grassland forbs, and rhizomatous, usually exotic grasses. The healthier woodlands have a relatively dense tree canopy, ash trees of all ages and understories dominated by chokecherry, wild plum, hawthorn, serviceberry, Sprengel's sedge, and shade-loving forbs. Most ash woodlands are intermediate in composition between these two extremes. There are several causes for the decline of green ash woodlands in Montana including woodcutting, grazing, deer browsing, introduction of invasive, rhizomatous sod grasses (i.e. Kentucky bluegrass), and climate. Tree recruitment is reduced by competition with sod grass. Even though recent livestock grazing and wildlife use have been implicated as the primary causes of woodland decline, the current condition of green ash draws may be more a reflection of past (1880 to 1930) grazing pressure (Lesica and Marlow, 2013). Regardless, it is essential to manage livestock in ways that are compatible with good-condition woodlands. Generally, higher density of green ash seedlings and saplings were in stands that had multiple-pasture, rotational grazing. Higher tree recruitment is generally found in winter pastures compared to summer pastures, as well as in stands farthest from water developments.

Within permitted grazing allotments on the Sioux District, 137 green ash woodland sites were inventoried of which 21 percent were found to be functioning, 63 percent were "at risk", and 22 percent were non-functional. On the Ashland District, of the 299 acres inventoried, approximately 16 percent were considered healthy, 59 percent considered at risk, and 25 percent considered not functioning. When averaging these two pine savanna units, 19 percent of inventoried areas are functional, 61 percent are "at risk", and 20 percent are non-functional. In addition, about 25 percent of the Ashland's and 16 percent of the Sioux's green ash woodlands are mixed forest and mixed savannah dominance types which is indicative of ponderosa pine colonization into green ash woodlands.

Aspen and Cottonwood

Background

Other broadleaf deciduous tree communities of interest include quaking aspen (*Populus tremuloides*) and cottonwood (black cottonwood (*Populus trichocarpa*), narrowleaf cottonwood (*Populus angustifolius),* and plains cottonwood (*Populus deltoides spp. monilifera* - formerly *P. deltoides var. occidentalis*). Table 22 displays acreage by landscape area.

Table 22. National Forest System acreage of deciduous broadleaf woodlands by landscape area, VMap 2015

Landscape Area	Cottonwood	Aspen
Montane Units		
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	379	11015
Bridger, Bangtail, Crazy Mtns	7	1184
Pryor Mtns	Present	108
Montane Subtotal	386	12307
Pine Savanna Units		
Ashland	Present	976
Sioux [19]	Present	509
Pine Savanna Subtotal	Present	1485

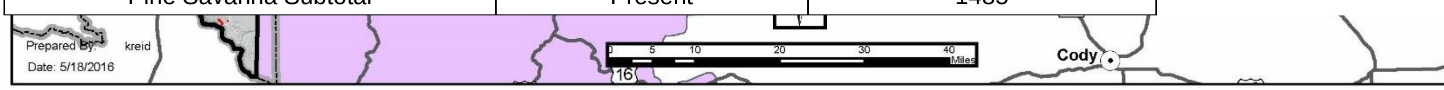

Figure 13 and Figure 14 depict their locations in the montane and pine savanna ecosystems.

[19] Vmap originally depicted 421 acres of cottonwood and 88 acres of aspen for the Sioux RD. However, it is highly likely that most of the cottonwood acreage is really aspen. Cottonwood is a very minor component on the District. Combining the acreages for 509 acres of aspen and presence of cottonwood on the Sioux RD is more representative (Buchanan, 2016. Pers. Comm.).

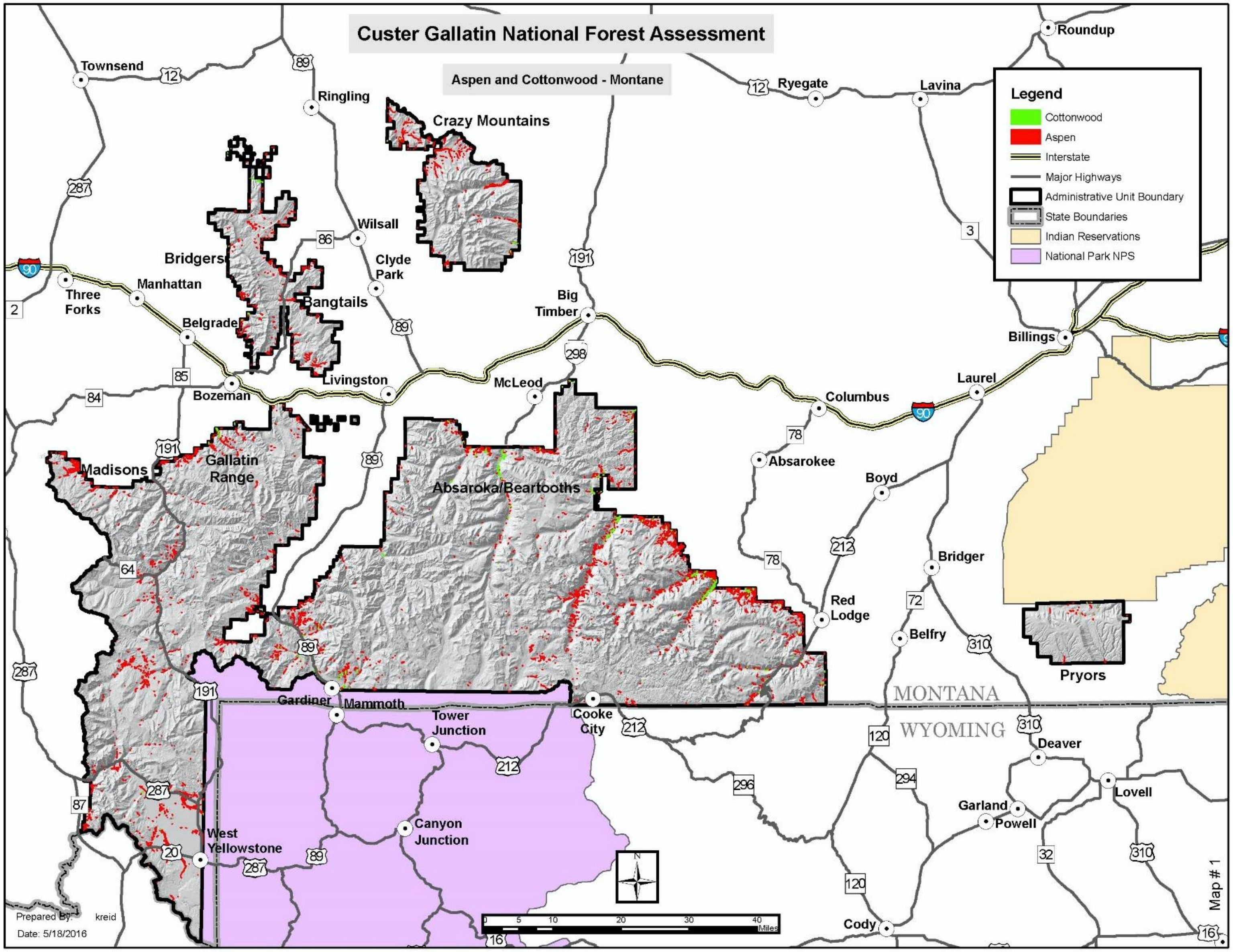

Figure 13. Aspen (red) and cottonwood (green) communities - montane

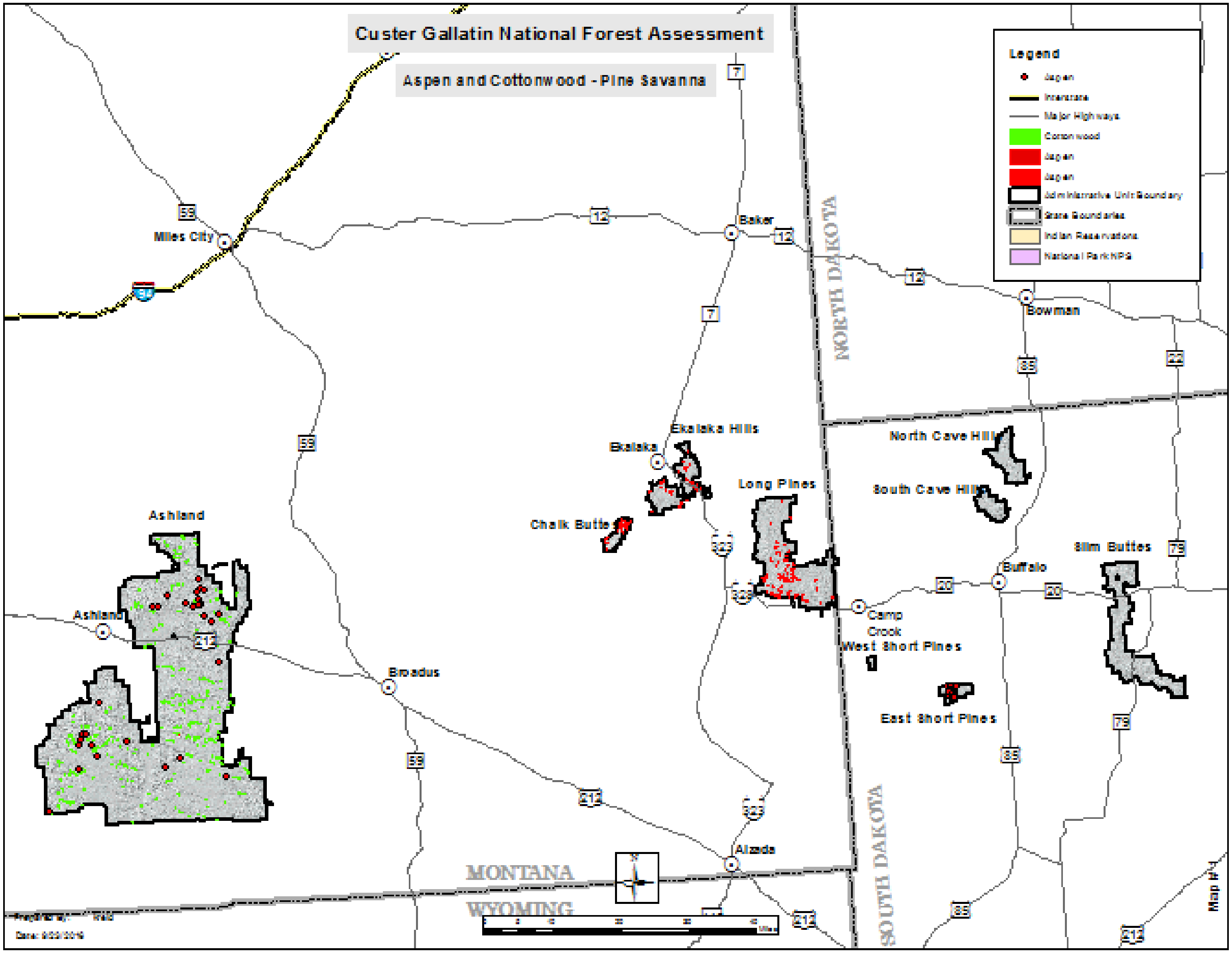

Figure 14. Aspen (red) and cottonwood (green) communities – pine savanna

Aspen

Aspen is highly valued for its contribution to biodiversity and habitat; with the exception of riparian areas and green ash woodlands, aspen communities are considered one of the most biologically diverse ecosystems in the Intermountain West (Campbell and Bartos 2001). As with coniferous forests, various habitat types are dominated by aspen. Nonetheless, aspen is not abundant in the Custer Gallatin National Forest (less than 1 percent of the land area), occurring primarily as small groves at middle and low elevations. It is most common on relatively moist sites characterized by fine-textured soils (Hoff 1957, Reed 1971).

Aspen reproduction typically is asexual, with new shoots produced from root sprouts (suckering; Barnes 1966, Bartos and others 1991). This, combined with the persistence of aspen in the understory of some mature forests, explains why aspen tends to develop where it occurred previously. Sexual reproduction is quite rare, though seedlings do occur when severe disturbances such as fire are followed by the extended moist conditions in the spring required for seedling establishment (McDonough 1985). For example, aspen seedlings were abundant in some areas in 1989 after the 1988 fires in nearby YNP (Romme and others 1995). Because of such requirements, sexual reproduction is thought to be episodic (DeByle and Winokur 1985, Romme and others 1997). There is considerable genetic diversity between clones, with some clones better adapted for higher elevations and some responding differently to weather conditions than others (Jelinkski and Cheliak 1992). For example, it is common to see two adjacent aspen stands (clones) in the fall, one with yellow leaves and the other with green leaves.

Aspen is a seral, relatively short-lived species which requires full sunlight to regenerate. The clonal habit of aspen adds to its uniqueness among tree species; even the most decadent clones should be recognized as superior genotypes that have survived the process of natural selection and are most likely some of the best suited genetic material for that site (Campbell and Bartos 2001). Aspen historically relied on fire or disease to remove the overstory, kill encroaching conifers, and stimulate a new generation of suckers from the existing clone root system. Mature aspen trees inhibit the growth and success of new suckers via auxins in their common root system. Without periodic self-regeneration, aspen stands become decadent and deteriorate as root systems decline (Shepperd et al. 2001). Mature clones can also decline due to repeated animal herbivory or competition from invading conifers (Shepperd et al. 2001). Table 23 outlines the acreage of cottonwood by landscape area and ownership within the proclaimed Custer Gallatin National Forest boundary.

Table 23. Acreage of aspen by landscape area and ownership

Area	Non NFS Land	NFS Land	Grand Total
Montane			
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns - Upland Setting	2566	5839	8405
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns - Riparian Setting	1280	4914	6193
Bridger, Bangtail, Crazy Mtns - Upland Setting	613	231	844
Bridger, Bangtail, Crazy Mtns - Riparian Setting	693	947	1640
Pryor Mtns - Upland Setting	23	62	85
Pryor Mtns - Riparian Setting	7	41	48
Montane Subtotal	5183	12034	17217

Area	Non NFS Land	NFS Land	Grand Total
Pine Savanna			
Ashland - Upland Setting	2	976	978
Sioux - Upland Setting	10	508	518
Pine Savanna Subtotal	12	1485	1497
Grand Total	5195	13608	18803

Cottonwood

Black, narrowleaf and plains cottonwood communities occur within the assessment area representing a small trace of the overall assessment area (approximately 2,900 acres). Lower elevation, higher stream order environmental settings suitable for cottonwood populations occur largely outside of the Custer Gallatin National Forest. Cottonwoods are highly valued for their contribution to biodiversity and habitat. Cottonwoods are fast growing bottomland tree. They have been classed as moderately tolerant to water-logged soils and are tolerant of short-term water inundation (FEIS Database, accessed 2016). Cottonwoods reproduce by seed or vegetatively by root crown or root sprouting. Seeds are dispersed in the late spring or early summer via wind or water to suitable establishment sites that consist of bare mineral soil with little competition from other vegetation. Formation of suitable establishment sites occurs at irregular intervals and is often related to large flood events (Rood and Mahoney, 1990). Through deposition of alluvial material and scouring, flooding often produces suitable establishment sites. Until roots reach the water table, trees are susceptible to drought.

Where plains cottonwoods occur along rivers, the fire frequency is estimated between 20 to 30 years. These riparian areas burned less frequently than the surrounding uplands; fires skip over or only burn a portion in these settings. Fires most likely occurred late in the growing season when the understory vegetation was cured enough to support a fire. Narrowleaf cottonwood fire return intervals largely depends on the fire return intervals of the adjacent communities (FEIS Database, accessed 2016).

Table 24 outlines the acreage of cottonwood by landscape area and ownership within the proclaimed Custer Gallatin National Forest boundary.

Table 24. Acreage of cottonwood by landscape area and ownership

Landscape Area	Non NFS Land	NFS Land	Grand Total
Montane Units			
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	426	415	841
Bridger, Bangtail, Crazy Mtns	47	12	58
Pryor Mtns	1	2	3
Montane Subtotal	474	429	902
Pine Savanna Units			
Ashland	553	Present	553
Sioux	59	Present	59
Pine Savanna Subtotal	612		612
Grand Total	1086	429	1514

Condition

Aspen. While there are stable climax aspen communities, most aspen is a fire-maintained, early seral component of a forested community; stands are declining in number and size; stressors include competition with and shading by conifers, typically due to fire exclusion, domestic and native ungulate herbivory, and increasing temperature coupled with declining precipitation; reduction of soil moisture may cause severe water stress which reduces aspen's ability to survive (for example, sudden aspen decline) and to reproduce both vegetatively and by seed, thereby reducing genetic variability.

Cottonwood. There has been a reduction in area due to conversion and development of floodplains; composition and structure of cottonwood forests have been altered due to changes in flow regimes; structural alteration (typically simplification) of the channel (for example, levees, bank armoring structures) has likely contributed to channel widening, or channel incision and loss of floodplain interaction; non-native trees which are more drought tolerant are already present along rivers and streams in eastern Montana; increased drought stress will likely favor these species over cottonwood; additional stressors include roads, along with domestic and native ungulate browsing (particularly on young cottonwoods).

Alpine

Background

Alpine communities are common but unique in the high elevations of the montane units of the assessment area. Approximately 121,000 acres of alpine vegetation occurs within the National Forest System lands of the assessment area. The alpine vegetation is dominated by various grasses, sedges, small shrubs and forbs that are able to withstand the severe environment characterized by high winds, low humidity, cold soil temperatures, high ultraviolet radiation, short growing season, low soil moisture, and great daily temperature fluctuations (Bliss 1956, Knight 1994).

The Beartooth Mountains are primarily composed of the largest expanse of alpine plateau in the lower 48 states. An assessment of the Beartooth Mountains alpine ecosystems was conducted in 2012 (Williams). Thirteen alpine plant associations were classified and described in this analysis. Many were similar to turf, cushion, snowbed, grassland and wetland alpine vegetation associations previously described for the Beartooth Mountains by Johnson and Billings (1962), Lesica (1993) and Bamberg (1961) and for the alpine ranges of the Beaverhead National Forest in southwest Montana (Cooper et al., 1997), Glacier National Park in northwestern Montana (Choate and Habeck, 1963; Bamberg and Major, 1968), the Big Snowy and Flint Creek ranges in central and western Montana (Bamberg and Major, 1968) and the Wind River Range in northwestern Wyoming (Potkin and Munn, 1987; Wells et al., 2015).

The alpine vegetation occurs in a mosaic of turf, cushion, grassland, snowbed, and wetland associations. Wind exposure, moisture, and timing of snow release have generally been considered to be the most important environmental factors determining the arrangement of vegetation above treeline. Wind often results in soil and snow removal on windward sites and soil and snow accumulation, along with increased soil development, on lee sites.

Turf is generally vegetation dominated by dwarf, fibrous-rooted graminoids. Turf communities generally occur on gentle terrain (ridgetops and slope shoulders) with appreciable soil development. Turf vegetation grades into cushion plant vegetation where wind exposure increases and/or soil development decreases.

Cushion plant communities are most likely to occur on ridgetops and saddles. Their compact growth form allows them to persist despite dry, windy, cold conditions and shallow, stony, nutrient-poor soils. These sites are often blown free of winter snow and exposed to increased direct solar insolation. This makes such sites the most xeric high-elevation sites and earns them the distinction of being labeled “alpine deserts.” Unlike other alpine communities, including turf communities, graminoids are generally less abundant than forbs in cushion plant communities.

Snowbed communities occur where prevalent wind patterns result in increased snow accumulation behind small ridges, on upper lee slopes and in depressions. Plants occurring in these microsites receive more moisture and experience shorter growing seasons, due to later snow-release, than adjacent communities.

Grassland communities generally occur in the lower reaches of the alpine zone on both gentle and steep slopes with deep soils and relatively warm climates. Alpine grasslands can be compositionally similar and even grade into high-elevation grasslands and sagebrush steppe. Grassland communities are similar to turf communities in that they are both graminoid dominated. However, alpine turf communities tend to occur on more wind-exposed slopes than grassland communities and are dominated by sedges and forbs of shorter stature than the more robust grasses characteristic of alpine grasslands. Alpine riparian and wetland communities occur in extremely wet sites, such as basins and local depressions.

Figure 15 displays alpine vegetation locations.

Table 25 summarizes alpine vegetation acreage by landscape area in the montane ecosystems and by ownership within the proclaimed Custer Gallatin National Forest boundary.

Table 25. Alpine vegetation acreage by landscape area and ownership

Landscape Area	Non NFS Land	NFS Land	Grand Total
Bridger, Bangtail, Crazy Mtns		Present	
Alpine Dry Grass (Turf)	184	650	834
Alpine Mesic Shrubland	4	4	7
Bridger, Bangtail, Crazy Mtns Subtotal	188	654	842
Madison, Henry’s, Gallatin, Absaroka and Beartooth Mtns			
Alpine Dry Grass (Turf)	902	116756	117658
Alpine Wet Grass	2	376	378
Alpine Mesic Shrubland	168	3238	3406
Madison, Henry’s, Gallatin, Absaroka and Beartooth Mtns Subtotal	1072	120371	121443
Grand Total	1260	121024	122284

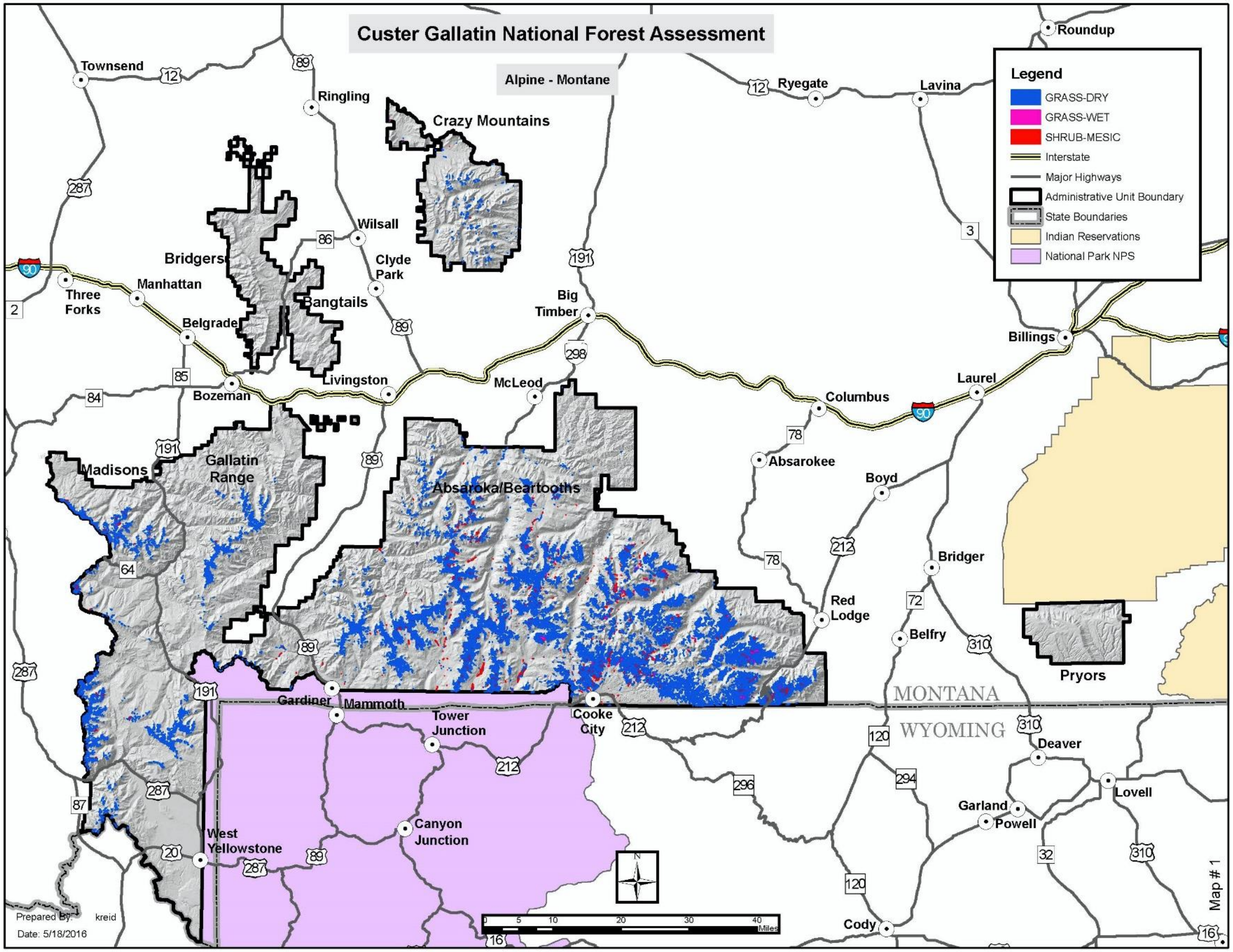

Figure 15. Alpine turf and shrublands

Condition

Substantial domestic sheep use in the alpine systems on the Custer Gallatin National Forest was occurring during the turn of the century. Because of the resource degradation they were causing, permitted livestock grazing has essentially been closed in most of these alpine areas. Because alpine areas are slow to recover, evidence of past livestock use still remains in some areas.

Historic gold mining in areas near the Cooke City area affected some the alpine systems. Extensive and costly reclamation to re-establish soil stabilizing vegetation have been conducted.

Sparse Vegetation

Background

Sparsely vegetated areas include the badlands of Sioux and Ashland Districts and the talus, rocky, and exposed ridges/slopes of the montane Districts. These unique habitats compose approximately 360,000 acres or 12 percent of the plan area and often provide specialized habitat for sensitive or rare plant species. Table 26 displays the amount of this cover type by landscape area.

Table 26. National Forest System acreage of sparse vegetation by landscape area, VMap 2015

Landscape Area	Sparse Vegetation
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	319,021
Bridger, Bangtail, Crazy Mtns	33,605
Pryor Mtns	657
Montane Subtotal	353,301
Ashland	3691
Sioux	3605
Pine Savanna Subtotal	7296
Grand Total	360,597

Condition

Sparsely vegetated areas are often described as talus, rocky sites, disturbed sites, exposed sites, or badlands. This setting occupies the fringes of adjacent systems, particularly dry habitats. Tree and herbaceous cover is often low due to limited soil development and dry growing conditions, site disturbance, or rocky conditions. This habitat includes natural rock outcrops as well as scree (that is, talus) and covers a wide range of rock types, varying from acidic to highly calcareous. Vegetation is sparse or largely lacking. Bryophytes and lichens often occur in crevices and flourish on open rock surfaces where the competition from vascular plants is absent. Species composition can vary widely, depending on the moisture regime and adjacent communities contributing to the seed source.

Plant Materials

Background

Various plant materials are used for foods (that is, berries), medicines (that is, echinacea), floral arrangements, ornamentals, contemporary traditional uses, etc. Markets for these various products have fluctuated. Permits may be issued for personal use or commercial use of species. Generally, personal use permits have been issued on the Custer Gallatin National Forest and commercial permits have been avoided. Species proposed for harvest and collection are assessed for the vulnerability and sustainability of the species and pertinent conservation approaches and restrictions are stipulated.

Medicinal Plants. About 30 species of roughly 110 native medicinal plants harvested in Montana have been listed as highly popular for collection. About 37 of these species are cultivated for the herb market (Klein, 2000). Klein and others (2002) provide estimates on what constitutes a personal amount of harvested plant material versus a commercial amount by species. For personal use amounts, none of the species exceeded two grocery bags full (wet, not dried, plant material).

Of the United Plant Savers "at risk" medicinal plant species considered sensitive to harvest and other human activities, echinacea (all *Echinacea* species), eyebright (all *Euphrasia* species), lady's slipper orchid (all *Cypripedium* species, lomatium (*Lomatium dissectum*), osha (*Ligusticum porteri*), sundew (all *Drosera* species) and trillium, (*Trillium ovatum*) are found within the Custer Gallatin National Forest. These species were, at one time, under a moratorium from harvest and removal. Even though the ban has been lifted, these species should receive close evaluation prior to permitting harvest. According to policy (Forest Service Handbook R1 Supplement No. 2409.18-2007-1), forest supervisors should use discretion when permitting these special forest products and only permit those medicinal species that are not listed on the threatened, endangered, or sensitive plant list. Scientific and research permits for these species may be issued to accredited schools, colleges, universities, or other institutions of higher learning, or to any government agency or to recognized Indian tribes having reserved rights for non-commercial gathering on National Forest System lands.

Echinacea or purple coneflower (*Echinacea angustifolia var. angustifolia*) populations are widely distributed across the Ashland and Sioux Districts of the Custer Gallatin National Forest. Echinacea is most often associated with the Great Plains region. It grows primarily in open, rocky pine savannas, but also occurs in drainages and depressions. It has been found in scattered and open ponderosa pine stands. Echinacea has a large tap root and extends 4.7 to 6.5 feet into the soil (FEIS online, accessed 2016).

Echinacea is one of the most popular, and most researched, plants in the herbal product industry. Echinacea has traditionally been used for colds, flu, and other infections, based on the idea that it might stimulate the immune system to more effectively fight infection. These plants are slow-growing, long-lived perennials, whose roots are the primary medicinal plant part used in the commercial trade. A sizable portion of the demand for echinacea is for wild-harvested plant material, especially roots of *Echinacea angustifolia*.

The popularity of echinacea products has repeatedly risen and fallen in recent history, cyclically renewing concerns that unregulated harvesting will decimate wild populations. Harvesting of *Echinacea angustifolia* root increased considerably in the mid-1990s, spreading northward from historical harvesting areas in Kansas to the essentially untouched large native stands on rangeland in eastern Montana and western North Dakota. Harvesting increased even more when the market demand doubled from 1997 to 1998. (Kindscher, 2008). Harvesters from Texas who had applied for, but had not received, a commercial permit were arrested in 1998 in the Ashland District with about 84 pounds (38 kilograms) of fresh roots. It is estimated that this harvest impacted close to 8,400 echinacea plants[20]. Montana and Wyoming both passed temporary emergency legislation for banning collection on public lands in early 1999 because of the severity of root digging observed in those states (not presently in effect).

Echinacea flowers are a major nectar source (Cochrane and Delphey 2002) for the Dakota skipper butterfly (*Hesperia dacotae*), a listed threatened species (Listed October 24, 2014), although it also uses

[20] It takes over 220 *E. angustifolia* plants to make 1 kg of dried Echinacea root (Kindscher, 2008).

other flowers for nectar (USFWS 2014). Dakota skipper distribution formerly included tallgrass and mixed grass pine savannas of Illinois, Iowa, Minnesota, South Dakota, North Dakota, and Manitoba. Their current distribution is centered in western Minnesota, northeastern South Dakota and the eastern half of North Dakota. It has been suggested there is a remote possibility that Dakota skippers may also occur in far eastern Montana and southeastern Saskatchewan, in habitats similar to those occupied by the species in northwestern North Dakota (Cochrane and Delphey, 2002). The closest known colony occurs many miles north in the Little Missouri National Grasslands of North Dakota.

Kindscher (2008) found that root harvests are killing half of the plants which suggests potential recovery of these populations, even after severe harvests. Full population recovery would require a period of at least two years without harvest plus the combination of root resprouting, seed bank germination, and small plants reaching flowering size. Kindscher (2008) recommended that with responsible harvest techniques, the harvest and removal of echinacea can be sustainable.

Traditional Plants. The Sioux, Northern Cheyenne, Crow, Bannack, Shoshone, Nez Perce, Flathead, and Kootenai Tribes have affiliations with the assessment area. There are many plant species that have traditional uses as food, medicines, industrials (paint traps, etc.) and rituals (i.e. incense; sweat lodge construction). Tribal members used trees, shrubs, and grasses as part of their survival and knowledge about their use has been handed down through generations. They have developed strong spiritual relationships with plants (Tallbull). Several plant species important to the Tribes important for traditional uses have been identified within the assessment area (Pers. Comm. H. LaPoint).

Commissary Ridge in the Pryor Mountains have been identified as a root-plant collection area for the Crow Tribe (bitterroot, sego lily, Indian turnip). Other plants there are edible, have medicinal uses, or industrial uses such as for tipi poles. The reddish clay ochre can be used for paint and chert that can be make stone tools. The area has been described as “the commissary, the storehouse of life to the Crow Indians” (Nabikov et al., 1994). Often, procuring materials used in various ceremonial situations, knowledge of key foraging spots are transmitted within the privacy of clan, family, or religious association groupings (Nabokov, et al., 1994).

Condition

Areas of echinacea grow in primary grazing areas of the Sioux and Ashland Districts. Many populations in the assessment area are in good condition and have been targeted by “poachers” who harvest without permission. Kindscher (2008) monitoring data from North Dakota, Montana, and Kansas shows that echinacea plants are abundant in areas where their populations are healthy, and many healthy populations of *E. angustifolia* are found especially in north-central Kansas, eastern Montana, and western North Dakota. Data, supported by statistical analysis (Kindscher et al. in preparation) demonstrates that 50 percent of monitored wild-harvested roots re-sprouted in both Kansas and Montana. *E. angustifolia* still occurs frequently over much of its historic range despite a long commercial harvest. Its global conservation status rank is G4, “apparently secure,” based on its wide range and large number of extant populations, although it is reported as declining (NatureServe 2016) given the boom and bust nature of the harvest market.

Ground Cover

Current policy directs that land condition inventory be conducted using current ecological concepts. The ecological approach to assess rangelands is rated relative to the observed or measured attributes (17 indicators) for the site, such as floristic similarity, structure, production, bare ground, litter amount, compaction, gullying, rilling, wind scouring, and presence of invasive species. From these attributes, interpretations are made about rangeland integrity and can be described in terms of biological integrity, hydrologic function, and soil and site stability (Pellant et al., 2005). Noxious weeds, ground cover, species composition, and shrub cover were attributes tested in a Forest Service Intermountain Region study (O'Brien et al., 2003) and proved to be viable indicators of rangeland health and function. For a consistent analysis across the CGNF plan area and based on available data the measures for key ecosystem indicators for rangeland health include the amount of bare ground and noxious weeds.

Ground Cover. Ground cover (basal vegetation, rock, wood, moss/lichen/crusts, and litter)[21] aids in soil stability and minimizing water and wind erosion. Bare ground does not aid in soil stability. Water and wind erosion decreases as vegetation cover increases due to increased water available for plant growth. When soils are dry and plant cover is low, potential erosion is high from both wind and water.

For upland water erosion, sediment yield is comparatively slight, down to around 70 percent ground cover, but it increases rapidly thereafter for equal rainfall events (Marshall, 1973). Enderlin and others (1962) also describe that ground cover between 70 and 100 is good, ground cover between 30 and 70 is fair, and ground cover between 0 and 30 is poor as adjective ratings. On the Gallatin elk winter range in Montana, ground cover of at least 70 percent was considered necessary for restoring and maintaining soil stability (Packer, 1963).

Ground cover is most often used to determine the watershed stability of the site, but comparisons between sites are difficult to interpret because of the different potentials associated with each ecological site (Coulloudon et al., 1999). The variability of different site potentials are shown in Mueggler and Stewart's (1988) classification of grasslands and shrublands of Montana which describes bare ground data for 30 non-forested habitat types found on the Custer Gallatin National Forest which depict reference conditions relative to the site's inherent capabilities. Bare ground in reference condition grassland types averaged 7 percent and ranged from 0 to 42. In the sagebrush types, bare ground averaged 9 percent and ranged from 1 to 32 percent. In skunkbush types, bare ground averaged 5 percent and ranged from 1 to 18 percent. Hansen and Hoffman's (1988) habitat type classification of grasslands and shrublands describes bare ground data for 26 non-forested habitat types found on the Ashland and Sioux Districts which represent reference conditions. Bare ground in reference condition on two juniper types ranged from 34 to 70. In two Wyoming big sagebrush types, bare ground ranged from 0 to 44 percent. The silver sage type's bare ground ranged from 1 to 16 percent.

Presence and amount of bare ground is a key indicator for overall ecosystem health. Basic ground cover and bare ground data were captured for 3,788 ocular macroplots during various vegetation inventories (in both forested and non-forested types). The inventories included rangeland inventories, satellite imagery validation (Silc/Vmap), and other legacy inventories. Bare ground ranging from 0 to 10 percent cover was found on 81 percent of the plots, bare ground ranging from 11 to 20 percent was found on 10 percent of the plots, bare ground ranging from 21 to 30 percent was found on 4 percent of the plots, bare ground ranging from 31 to 40 percent was found on 2 percent of the plots and bare ground ranging from 41 to 100 percent was found on 3 percent of the plots. Ninety-five percent of the overall plots had 30 percent or less bare ground with 81 percent being at ten percent or less.

---

[21] Ground cover is the cover of basal vegetation, litter, downed wood, rocks, and gravel on a site. Vegetation cover is a component of ground cover and is often sensitive to climatic fluctuations that can cause errors in interpretation. Canopy cover and foliar cover are components of vegetation cover and are the most sensitive to climatic and biotic factors. As such, for trend comparison, basal plant cover (plants measured at or near ground level) is generally considered to be the most stable and is the metric used. It does not vary as much due to climatic fluctuations or current-year grazing.

Table 27. Custer Gallatin National Forest percent bare ground

Area	0-10%	11-20%	21-30%	31-40%	>40%
Gallatin Portion - Percent of Plots (n-=647)	85%	8%	3%	2%	2%
Custer Portion - Percent of Plots (n=3141)	80%	11%	4%	2%	3%
CGNF – Total Percent of Plots (n=3788)	81%	10%	4%	2%	3%

When long-term trend monitoring sites are re-measured, a change in bare ground helps with the interpretation of the overall site's trend in condition.

Invasive Plants

Invasive plant species can alter the composition and diversity of riparian areas if left unmanaged. The invasion of vulnerable lands by noxious weeds poses a serious threat to the conservation of native plant communities. Invasive weeds lower plant diversity. Plant diversity is needed to maintain healthy plant communities that resist weed invasion. Invasive weeds can outcompete most native plants for soil nutrients and water. See separate Invasive Plant Species Report for detailed information.

Of the 75,438 acres of riparian vegetation found in the montane units, 1,245 acres or 2 percent are infested with invasive plant species. These are predominantly Canada thistle. Of the 2,101 acres of riparian vegetation found in the pine savanna units, 268 acres or 13 percent are infested with invasive plant species. Canada thistle is the predominant species. Salt cedar has been found near the bounds of the pine savanna units. In the overall assessment area, approximately 5 percent of the riparian areas are infested with invasive plant species.

Table 28. Invasive plants in riparian areas – montane and pine savanna units

Riparian Lifeform	Riparian Acres (NFS)	Invaded Acres	% of Riparian Invaded
Montane Units			
Riparian-Aspen	5896	582	10%
Riparian-Cottonwood	327	100	30%
Riparian-Graminoid	19172	387	20%
Riparian-Shrub	2270	176	8%
Montane Subtotal	27665	1245	5%
Pine Savanna Units			
Riparian-Graminoid	496	54	11%
Riparian-Green Ash Woodland	1476	196	13%
Riparian-Shrub	129	18	14%
Pine Savanna Subtotal	2101	268	13%
Grand Total	29766	1513	5%

Presence and amount of invasive/noxious weeds is a key indicator for overall ecosystem health. The 2016 watershed condition framework assessment identified that most noxious weeds affect less than 10% of each individual watershed (sixth code hydrological units). However, six watersheds were identified as having a noxious weed footprint of between 21 to 54 percent of the watersheds. Weeds in Lower Mill, Bloom Cr., Paget Cr., and Horse Cr. Watersheds were exacerbated by wildfires in those areas. Some weeds in these areas have been treated, but seed banks likely exist and influence overall footprint for weed risk. As infestations increase in size, a containment strategy is typically used to treat the periphery of the area rather than attempting eradication which is generally not feasible given limited resources. See the Invasive Plants report for further detail. The six watersheds are outlined in Table 29, Figure 16, and Figure 17.

Table 29. Percent of watershed with noxious weed cover

Landscape Area	Watershed # (HUC 12)	Watershed Name	Watershed NFS Ac	Gross Infested NFS Ac	% of NFS Watershed with Noxious Weeds
Madison, Henry's, Gallatin, Absaroka and Beartooth Mountains	100700010902	Yellowstone River-Reese Creek	7556	2430	32%
Madison, Henry's, Gallatin, Absaroka and Beartooth Mountains	100700020305	Lower Mill Creek	14353	7716	54%
Pryor Mountains	100800140401	Sage Creek-North Fork Sage Creek	15655	3302	21%
Ashland	100901020203	Otter Creek-Horse Creek	17957	6819	38%
Ashland	100901020207	Paget Creek	8702	2597	30%
Ashland	100902070206	Bloom Creek	24496	5257	21%

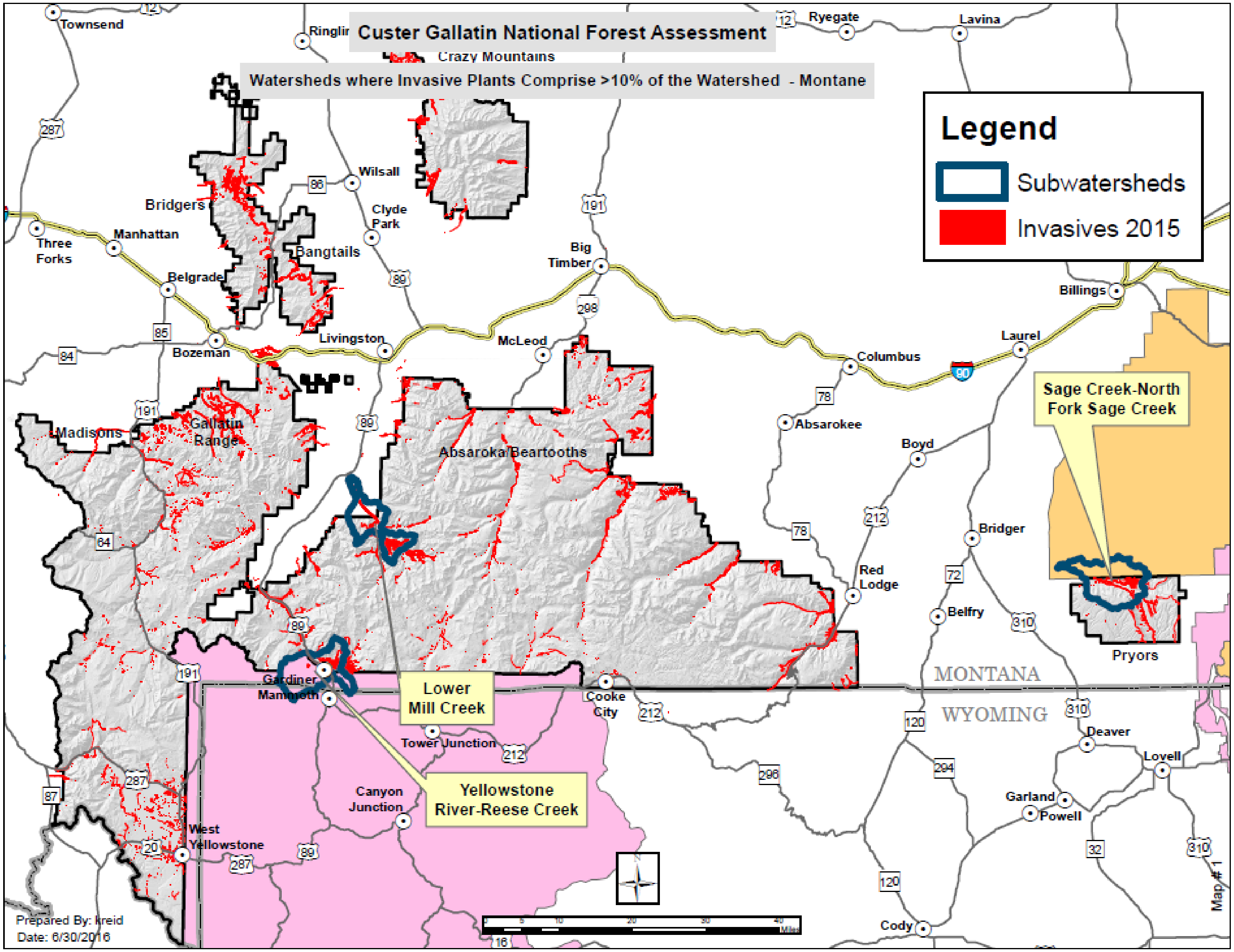

Figure 16. Watersheds with greater than 10 percent invasive plant species - montane

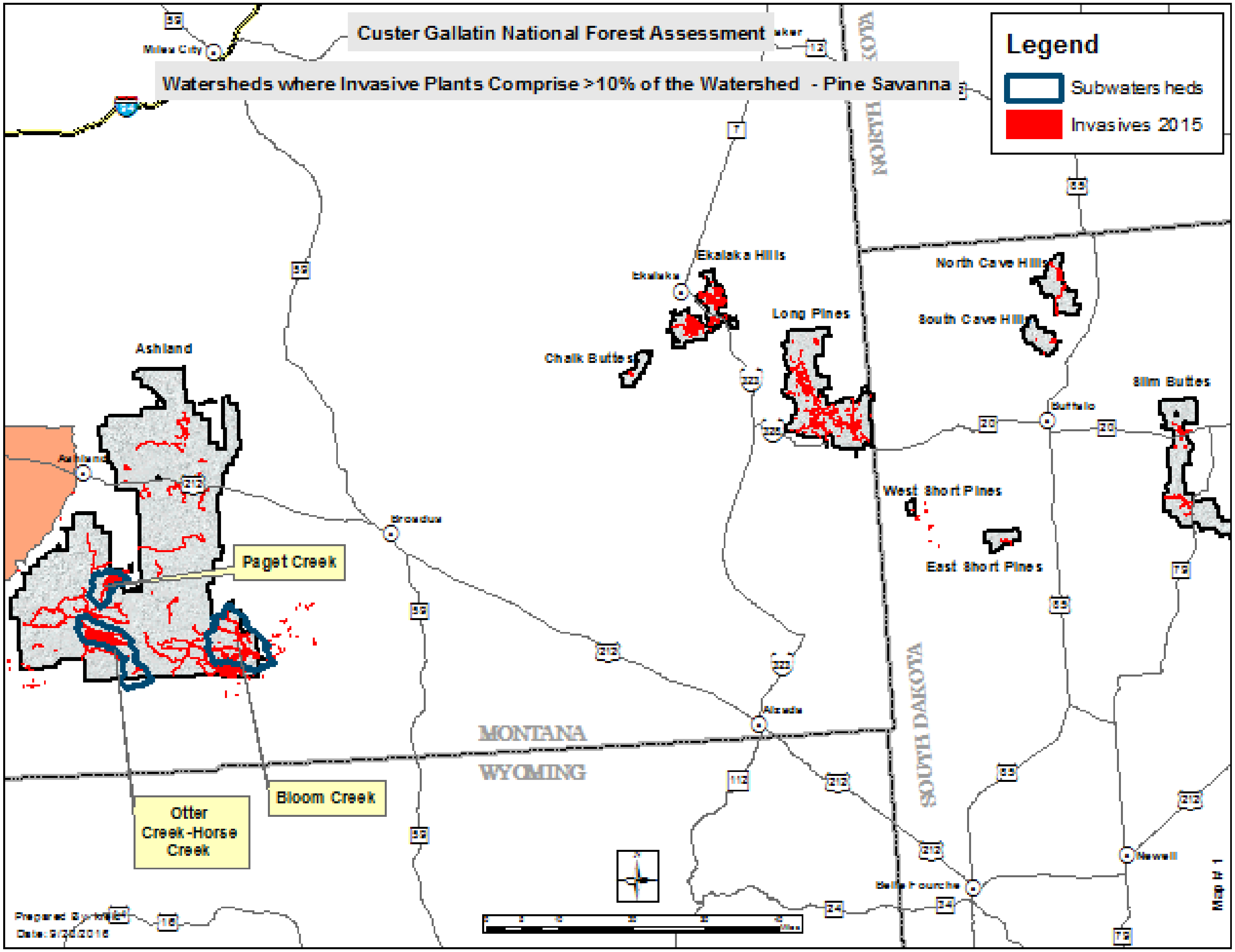

Figure 17. Watersheds with greater than 10 percent invasive plant species - pine savanna

Pattern and Processes

Presettlement conditions of southern Beaverhead County, just west of the Custer Gallatin National Forest, were assessed by Lesica (2009). His study was conducted in similar settings as the Custer Gallatin. Lesica found that the vegetation there is much the same today as it was during the 19th Century. Forests dominated by Douglas fir occurred on cool slopes. Aspen groves were common in moist, cool, or depressional sites in some foothills areas. Juniper and mountain mahogany were associated with rocky outcrops. The dominant upland vegetation was a mosaic of fescue-wheatgrass grasslands and sagebrush steppe. Riparian areas along small and most large streams were dominated primarily by willows. Drier terraces supported stands of basin big sagebrush (Lesica 2009). The information compiled by Lesica also suggests that a number of substantial vegetation changes have occurred since European settlement. Primary historical disturbance regimes for non-forested vegetation in the assessment area include climate, fire, and herbivory.

Climate

Rangelands usually occur in more arid environments, either due to edaphic or climatic factors. These arid conditions present challenges for studying the effects of climate change because some rangelands will be less resilient to changes in environmental influences such as fire regimes and periodicity of precipitation. Defining resilience for rangelands is important for estimating possible effects of climate change. Generally speaking, resilience refers to the capacity of ecosystems to regain structure, processes, and functioning in response to disturbance (Reeves, et al. NRAP, in preparation), whereas resistance describes capacity to retain these community attributes in response to disturbance (Reeves, et al. NRAP, in preparation). These concepts are especially critical when considering establishment of non-native plants and interactions between climate change stressors (Reeves, et al. NRAP, in preparation). In the northern Rockies, areas receiving higher precipitation and cooler temperatures result in greater resources and more favorable conditions for plant growth and reproduction (Reeves, et al. NRAP, in preparation). Management for ecosystem services derived from rangelands will be relatively more effective in more mesic rangelands.

In Figure 18, resilience to disturbance (A) and resistance to cheatgrass (B) over a typical temperature/precipitation gradient in the cold desert are depicted. Dominant ecological sites occur along a continuum that includes Wyoming big sagebrush on warm and dry sites, to mountain big sagebrush on cool and moist sites, to mountain big sagebrush and root-sprouting shrubs on cold and moist sites. Resilience increases along the temperature/precipitation gradient and is influenced by site characteristics like aspect. Resistance also increases along the temperature/precipitation gradient and is affected by disturbances and management treatments that alter vegetation structure and composition and increase resource availability (Chambers et al., 2014; Reeves, et al. NRAP, in preparation).

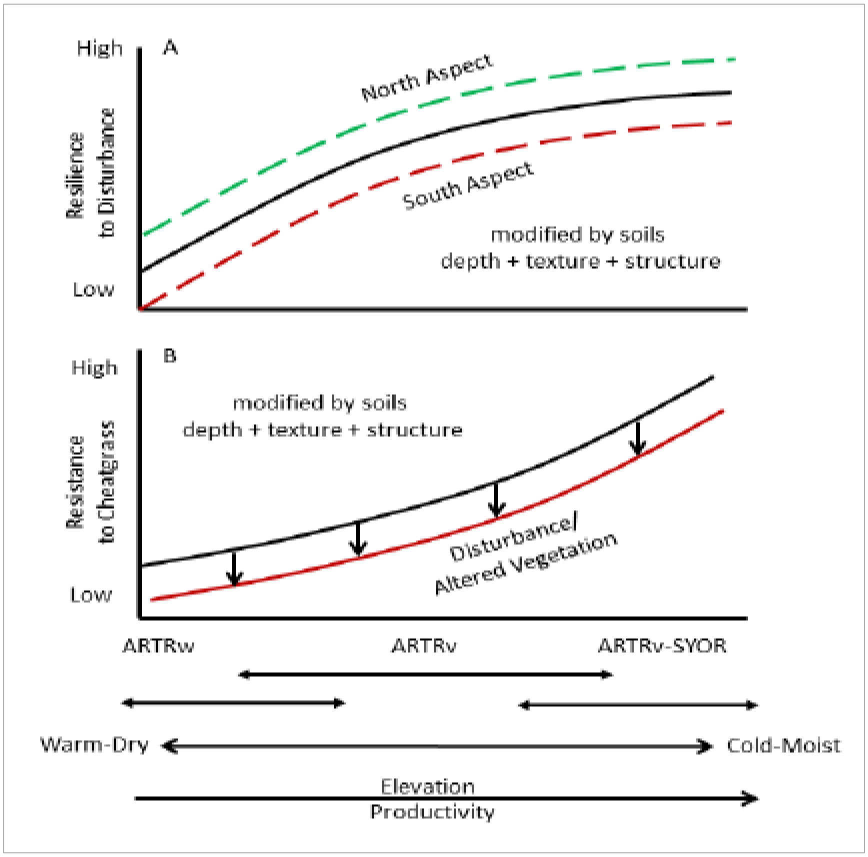

Figure 18. Resilience to disturbance and resistance to cheatgrass in Wyoming big sagebrush (ARTRw), mountain big sagebrush (ARTRv) and mountain big sagebrush - snowberry (ARTRv - SYOR) settings

Fire

The natural fire regime is a classification of the role fire would play across a landscape in the absence of modern human intervention but including the influence of aboriginal fire use (Barrett et al. 2010). Fire regimes are based on the average number of years between fires (fire frequency or *mean fire interval*) combined with *severity* (the amount of vegetation replacement) and its effects to the dominant vegetation. Rocky Mountain riparian area generally fall within the fire regimes of 7- to 350-year frequency. Great Plains riparian areas generally fall within the fire regimes of 14- to 100-year frequency; with mixed / low severity (FEIS, 2016).

Fire was a relatively common disturbance prior to European settlement. As a result, most non-forested areas exhibit a number of characteristics that are well suited to a fire-prone landscape. Fire in grasslands are generally more beneficial then harmful. Fires occur as a natural way for grasslands to recycle the organic material in them. Plants that are indigenous to grasslands generally have a special feature that differs from plants of other lifeforms. This feature is that their buds grow below ground, keeping them safe during the high heat of a grassland fire, although fire mortality can occur in some cool season grasses. Fires also help to kill or damage trees that are colonizing into grasslands and shrublands.

Herbivory

Grazing

Permitted livestock, large wild ungulates, and wild horses graze in the assessment area. This includes bison expansion from Yellowstone National Park.

Grazing is a dynamic process that interacts with complex landscapes to form disturbance and vegetation patterns that are critical to biodiversity. Because of this, the effects of grazing can be confounded by many factors, including those associated with animals and the environment.

Grazing in history, particularly by bison (*Bos bison*), contributed to shaping the grassland ecosystem diversity found within the assessment area. Many plants have adopted flexible growth strategies that enable them to tolerate bison herbivory pressures as well as herbivory by other ungulates, rodents like Pine Savanna dogs and invertebrates (Detling and Painter 1983, Painter et al. 1989). Because of their current limited distribution, bison no longer function as a major disturbance factor nor influence ecosystem function in most of their former habitat. Within the last hundred to hundred fifty years, bison were replaced across most of their natural range by domestic cattle.

Ecologists, conservationists, and land managers have studied and debated the effects of grazing by bison and domestic cattle (*Bos taurus*), often without including other relevant factors (Plumb and Dodd 1993; Hartnett et al. 1997; Steuter and Hidinger 1999). Studies that compare these two species are challenging because they could easily be confounded, as it would be expected that bison and cattle herds differ in number, age, sex, access to resources, and presence of disturbances.

Compared to domestic cattle, studies on bison in the Henry Mountains (Utah) indicated bison wander more, are less apt to re-graze a site during a single growing season, will use steeper terrain, select and consume drier, rougher forage, and spend less time in riparian areas and wetlands (Van Vuren 1979). Cattle, however, are typically managed in smaller landscapes with more of a “press” from longer grazing durations while historic bison use was over larger landscapes grazed with more of a “pulse” of shorter duration in their use of grasslands.

Both of these herbivores have a strong preference for recently burned areas. This would suggest that evaluation of differences between these species may be irrelevant to pre-settlement landscapes unless fire is incorporated. With regard to restoration and conservation, restoring the fire grazing interaction is perhaps more important than the specific species of large herbivore.

During the growing season, bison strongly select for high quality regrowth on burn areas (Biondini et al. 1999) or for large, open grasslands (Steuter et al. 1995). In contrast, the spatial distribution of cattle is largely controlled by the manager's decisions, and in relation to pasture cross-fences and stock density.

Topography, soils, vegetation, and animal behavior influence cattle and bison distribution in unburned mixed Pine Savanna (Sneft et al. 1987; Steuter et al. 1995). However, when the same landscape is managed with a fire regime that mimics historic fire frequency and season, the effects of fire override topography and soil in determining bison distribution (Biondini et al. 1999). The interaction between bison and fire results in a coarse, dynamic vegetation pattern not present in cattle managed landscapes. Diversity in vegetation structure, resulting from either fire plus bison grazing or cattle management, can provide habitat opportunities for a variety of grassland birds (Griebel et al. 1998; Kantrud 1981), and invertebrate species (Fay 1998).

Grazing frequency and intensity are related to water distribution as well as to fire (Sneft et al. 1987). The naturally-occurring wetland and riparian areas that once influenced grazing distribution are now supplemented with stock wells and dams for both bison and cattle. Side-by-side comparisons suggest bison spend less time grazing and loafing next to water sources and, as a result, the animal impact zone is smaller and less severe (Van Vuren 1981). However, bison in the sandhills select riparian zones mixed pine savanna during the spring and fall forage transitions. During these transition periods, cool season grasses are still growing in the woodland understory, while the uplands are dominated by warm season grasses that are dormant.

Topography is also important. Bison prefer to use open, gently rolling uplands, especially when they are in large breeding herds during July and August (Steuter et al. 1995). In contrast, cattle are attracted to the shade of woodlands and riparian zones, both during the heat of the summer and for protection from wind and cold during the winter (Smoliak and Peters 1955; Sneft et al. 1985; Van Vuren 1981). This contrast between bison and cattle does not persist in the mountainous west, where dense rhizomatous graminoids dominate riparian zones and relatively sparse bunch grass communities dominate the uplands (Mack and Thompson 1982). Bison appear to select riparian areas similarly to cattle in the intermountain West.

Many schemes of planned grazing on the landscape have been designed to sustain cattle production and grassland productivity (for example, Heitschmidt and Stuth 1991). In general, a single herd of cattle is moved throughout the growing season among multiple, fenced pastures to harvest high-quality forage. This allows regrowth in temporarily-deferred pastures, to restore plant vigor following grazing. The season(s) of grazing for individual pastures can be shifted between years to maintain the preferred composition of forage species, or they can be held constant to change the plant composition in favor of a particular group of plants. Plant community response to grazing, and the "manageable" nature of cattle, suggest that planned grazing with cattle can be used to meet specific conservation goals as well as production objectives (Steuter 1995).

Whether managing with bison or with cattle, the stocking rate and grazing management will determine the long-term health of both the rangelands and grazing animal. Based on evolutionary history and domestication traits, cattle may be more appropriate in intensively managed agricultural systems. Bison may be more appropriate in extensively managed, larger grasslands.

Conservation of bison is important as they are an iconic species and a keystone herbivore that interacted with fire and other disturbances to create a shifting mosaic across much of North America. However, from a broad context, conservation efforts should recognize that cattle will likely continue to be a dominant feature on these landscapes, and that some conservation objectives can be met with cattle (that is, restoring critical ecosystem processes such as with fire - grazing interactions).

While propositions to restore or conserve natural landscapes regularly focus on native herbivores (e.g., Sanderson et al. 2008), it is often overlooked that many natural landscapes are privately owned and used for domestic livestock production (Samson and Knopf 1994). It is important to state that low and high conservation values can be achieved with both bison and cattle. Though bison are the iconic symbol of the these landscapes and it is important that the species be conserved, there is not enough information to confidently state that landscapes with bison are inherently better for overall biodiversity than landscapes with cattle without considering the many other factors that interact with grazing. Both species can be mismanaged and cause degradation of habitat for other species as well as ecological processes, such as nutrient and water cycling.

Rangeland Insects

Grasshopper and Mormon cricket outbreaks in grasslands and shrublands periodically occur in the assessment area. These insects have been serious pests in the Western States since early settlement. Weather conditions favoring the hatching and survival of large numbers of insects can cause outbreak populations, resulting in damage to vegetation. The consequences may reduce grazing for livestock and result in loss of food and habitat for wildlife.

Grasshoppers and crickets are closely related insects—both belong to the order Orthoptera. Mormon crickets are a flightless species of long-horned grasshopper. Grasshoppers occur throughout the North American continent and around the world; however, Mormon crickets are mostly found in the Great Basin and other areas of the western United States. Mormon crickets and grasshopper outbreaks have been known to occur in the Pryor Mountains in the assessment area. Grasshopper outbreaks have also been known to occur in the Ashland and Sioux areas.

The total number of grasshoppers in an area is less important than determining the number of pest species per unit area when deciding whether or not control measures are necessary. There are about 400 grasshopper species in the western United States (APHIS, 2002). A typical rangeland area, over the course of 1 year, has 15 to 40 species (APHIS, 2002), but not all grasshopper species cause economic concern. There are about two dozen western grasshoppers that can be considered pests to agricultural production.

Grasshopper and Mormon cricket treatments could potentially disturb sensitive status species during critical life stages. In addition, grasshoppers provide a food source for many species, for instance grasshoppers and other insects are important for sage-grouse chicks during early brood rearing. However, extreme grasshopper outbreaks can cause massive defoliation and the loss of forbs, reducing nesting cover for the following spring and reducing another important food source for sage-grouse.

In 2002, the Animal and Plant Health Inspection Service (APHIS) completed an environmental impact statement document concerning suppression of grasshopper and Mormon cricket populations in 17 western states, including Montana and South Dakota (APHIS, 2002). The environmental impact statement described the actions available to the Animal and Plant Health Inspection Service to reduce the destruction caused by grasshopper populations. In April 2014, the Animal and Plant Health Inspection Service and the Forest Service (FS) signed a memorandum of understanding detailing cooperative efforts between the two groups on suppression of grasshoppers and Mormon crickets on national forest system lands. This memorandum of understanding clarifies that the Animal and Plant Health Inspection Service will prepare and issue to the public, site-specific environmental documents that evaluate potential impacts associated with proposed measures to suppress economically damaging grasshopper populations. The memorandum of understanding also states that these documents will be prepared under the Animal and Plant Health Inspection Service implementing procedures under the National Environmental Policy Act with cooperation and input from the Forest Service.

The memorandum of understanding further states that the responsible Forest Service official will request in writing the inclusion of appropriate lands in the Animal and Plant Health Inspection Service suppression project when treatment on national forest land is necessary. The Forest Service must also approve a pesticide use proposal (Form FS-2100-2) for the Animal and Plant Health Inspection Service to treat infestations. According to the provisions of the memorandum of understanding, the Animal and Plant Health Inspection Service can begin treatments after it issues an appropriate decision document and Forest Service approves the pesticide use proposal.

During outbreaks, the Animal and Plant Health Inspection Service locally suppresses damaging insect infestations to control threats to their area farmer's livelihood. Suppressing grasshopper/Mormon cricket infestations on adjacent federally administered or private range lands help decrease economic losses to forage and croplands by invading insects. Suppression can reduce the need for supplemental feeding of livestock, minimize ranchers displaced from grazing lands due to early loss of forage from insect damage, and the selling of livestock prematurely.

Key Benefits to People

Key contributions to social and economic sustainability from ecosystem services, multiple uses, infrastructure, and operations.

Non-forested lands are managed for a wide variety of values. Most commonly they are thought of in the context of their ability to provide forage for domestic livestock and big game animals; however, they also provide for a wide range of habitat needs (such as nesting or denning areas) for many wildlife species. In addition, they are highly valued for their abilities to capture and store water, for their recreational and scenic values, for their cultural and historic contexts, and even at times for their ability to produce a variety of products including firewood, posts and poles, and medicinal or other valued plant products. See the "Grazing" and "Riparian" sections for additional information.

Riparian habitats are among the most critical elements of biodiversity within the landscape and they provide key ecosystem services available from no other resource. This includes ecosystem-supporting services such as nutrient cycling; provisioning services such as fresh water, forage and habitat for wildlife; regulating services such as carbon storage, water and flood regulation, water quality, erosion control; and cultural services such recreation, scientific discovery and education, cultural, intellectual and spiritual inspiration.

Riparian areas are often important for the recreation and scenic values. Riparian areas contribute to nearby property values through amenity and views. Space is created for riparian sports such as fishing, swimming and launching for vessels. However, because riparian areas are relatively small and occur in conjunction with watercourses, they are vulnerable to severe alteration and damages caused by people and their activities.

Riparian areas supply food, cover, and water for a large diversity of animals and serve as migration routes and stopping points between habitats for a variety of wildlife. In Montana and South Dakota, many vertebrate species use riparian areas for a good portion of their life cycles, and many of these are totally dependent on riparian areas. Likewise, aquatic and fish productivity are directly related to a properly functioning and healthy riparian habitat.

Riparian areas help control nonpoint source pollution by holding and using nutrients and reducing sediment.

Tree, shrub, grass, and grass-like species in riparian areas stabilize streambanks and reduce floodwater velocity, resulting in reduced downstream flood peaks.

Where riparian areas are intact and functioning, these ecosystem services can be assumed to be stable; but where riparian areas have degraded or been lost, these services are missing or at risk.

The needs, and requests, of the local and surrounding communities for the Ashland and Sioux Districts are driven predominantly by commodity interests such as ranching while the community interest, locally and regionally are driven predominantly by amenity interests such as hunting, fishing; sight-seeing and other recreational pursuits. Aspen, cottonwood, and green ash stands are a vital part of the Custer Gallatin National Forest ecosystems, and are an extremely important part of the Forest's scenic quality, recreational opportunity, and wildlife habitat.

Some level of private land development in the six counties surrounding the Custer Gallatin National Forest will occur regardless of management activities on the Custer Gallatin. However, management decisions on the Custer Gallatin that might result in increased levels of development or subdivision of the deeded lands below will likely result in public land access problems, complications for management of big game herds, loss of wildlife habitat, and/or reduction in open space across the area.

Recreation use generally has little effect upon non-forested vegetation except in the case of repeated or continual uses such as camping, fishing, and hiking, or off-road vehicle use. Such uses tend to return succession to an early seral stage – even to bare soil on trail systems and in very popular dispersed camping sites, for example – but generally the number of acres impacted is a very small percentage of the total non-forested acreage across the Forest

Past road construction has had the effect of contributing to a reduction of acres of native meadows and shrublands; roads constructed in and along valley bottoms have reduced and/or altered riparian vegetation and sometimes changed stream channel location and function. Roads tend to create one of the largest impacts on the health and sustainability of stream/riparian/wetland systems. Effects include lowered water tables, altered morphology, changed sediment regimes, and removal of canopy cover and other vegetation. Currently, unauthorized off-road vehicle travel has an effect in moving rangeland vegetation to an earlier seral condition.

If oil and gas leases result in exploration activity and if any sites then go into production the amount of rangeland vegetation that could move to an earlier seral stage is dependent upon the amount of exploration and resultant production, but is expected to be minimal across the Custer Gallatin National Forest.

Market cycles and demand for echinacea have fluctuated in recent years, caused by both cycling in the herbal products industry and reaction to studies relating the efficacy of echinacea use to fighting the common cold and other ailments. Market cycling is likely to continue, and it will greatly affect the demand for wild-harvested echinacea. Even though the demand for echinacea reached its highest level in 1998 and has since declined, the market activity of the past decade suggests that the boom-and-bust harvesting of *E. angustifolia* is likely to continue (Price and Kindscher, 2007; Kindscher, et al. 2008). Cultivation on other lands in place of wild harvesting could provide relief to wild stands, but the difficulty of cultivating *Echinacea angustifolia*, coupled with a very uncertain market and a recent history of inability to market cultivated crops when the market crashes, makes it difficult for growers to be very enthusiastic about growing a crop that ties up land for more than one year and may or may not have a market when it is ready to harvest. Wild stands of echinacea will continue to be used until there is a higher and more stable price for cultivated *Echinacea angustifolia*. Fortunately, some wild-harvesting practices (such as those in north-central Kansas, where harvest has occurred for over 100 years) may be relatively sustainable.

Trends and Drivers

The composition and structure of the non-forest systems will continue to be influenced by the same succession and disturbance processes that shaped them. Accordingly, the vegetation will change with time. Natural disturbance events and succession will continue to operate. Management actions will influence vegetation by the degree to which natural disturbance events are allowed to operate and according to the levels of various human-caused disturbance events, such as grazing and prescribed burning. Both natural and human-caused disturbance processes will influence succession. The degree to which succession is influenced depends in large part on the magnitude and type of disturbance and the conditions that existed prior to the disturbance. Vegetative composition resulting from the interaction between succession and natural disturbance is difficult to predict in anything but in general terms.

Succession is the progression of change in composition, structure, and processes of a plant community through time. It is based on the concept that every species has a particular set of environmental conditions under which it will reproduce and grow. As long as these conditions remain fairly constant, the species will flourish. Plants impact their environments and each other, and this causes the community to change over time. The successional process follows a pathway with major steps referred to as a seral or successional stage. In a simplified model for a non-forested vegetation, early successional stages typically follow a stand-replacing disturbance (for example, fire), which kills all or a portion of existing plants while leaving the physical environment intact. Trees, shrubs, grasses and other plants start re-colonizing the site to fill up available growing space. Then, a series of intermediate successional stages follows, referred to as mid and late successional stages, where established species grow larger and denser based on site capability to make full use of resources. During these stages, new plants may be inhibited by high site occupancy or initiated in opening gaps as competition based mortality occurs. Changes in environmental conditions and competition for limited resources cause some species to decline and others to expand. The classical model of succession culminates in the climax community, a state of relative stability in composition, structure, and function, with all existing species able to perpetuate themselves without catastrophic disturbance.

This description of successional stages and associated characteristics is an oversimplification of what is in reality a far more complex and tangled web of inter-relationships between site conditions, vegetation and the ecosystem drivers and stressors. Highly diverse non-forest conditions can occur within any one successional stage and age. Time spent within a stage varies, and transition between stages is often gradual (except in the case of a stand-replacing disturbance that initiates the early successional stage). The abiotic conditions of a site (e.g., soils, aspect, and climate) and the disturbance types and patterns are key to understanding the different vegetation communities that may occupy the site and their characteristics over time.

There is a need to recognize site capability when considering restoration activities. Plant communities that can ultimately occupy a site are dependent upon current plant composition, the inherent potential of the soil on the site to produce specific plant communities, the probable climatic patterns and environmental processes, conditions or constraints that will likely occur, and the suite of management actions and resources available. In some areas, thresholds have been crossed where one or more ecological processes responsible for maintaining a vegetative state have degraded beyond the point of self-repair. Once a threshold has been crossed, the degree of investment and action required to reverse the transition is typically significant. Examples include 1) areas where wildfire combined with green ash woodlands understory vegetation that have been altered by turn of the 20th century unmanaged grazing have promoted higher density sod resulting in lower likelihood of green ash establishment from seed, 2) mesic foothills that have been altered by turn of the 20th century unmanaged grazing and adjacent private land past introduction and spread of non-native timothy grass and, 3) past seeded areas that are still dominated by non-native species such as smooth brome. This does not dismiss that fact that there continues to be “fine-tuning” needs at very site-specific scales at various locations.

Where projects have been developed to conserve riparian areas or to rehabilitate and restore riparian areas, local conditions might be expected to improve, and these areas can move closer to desired and proper functioning condition. However, external factors such as climate change, fire, floods, invasive species spread, and drought can be assumed to continue to exert stress on these areas.

Invasion by aggressive exotic plants is one of the greatest threats to the ecosystems in Custer Gallatin National Forest. Undoubtedly, recovery patterns have been less desirable where exotic plants are common. In Montana, studies show spotted knapweed is increasing, reducing the value of winter range for elk (Rice and others 1997). Stohlgren and his associates (Stohlgren and others 1999a, 1999b) found that habitats in the Rocky Mountains of Colorado with high native species diversity, such as aspen groves and some meadows, often are the habitats where exotic plant invasion is most likely. In general, the presence of exotic plants is likely to push many stand variables beyond their natural range of variability.

Climate

General. Most models predict that northern latitudes will warm while maintaining or increasing precipitation. This combination of factors should enhance productivity on northern and high-altitude rangelands through increased growing seasons for some time. If temperatures continue to rise, however, as suggested in all of the Resources Planning Act climate projections (USDA Forest Service, 2010), gains in production related to longer growing seasons and increased precipitation may be offset by decreased moisture availability at some time in the future. Despite this possibility, recent research suggests that increased temperatures, when coupled with increased carbon dioxide, actually improve plant water relations because of decreased transpirational demand (Morgan et al. 2011).

Although the vegetation cover types will change with time, habitat types (potential vegetation types) will remain relatively stable because they are based on physical site factors. However, with climate change and shifts in moisture, temperature and other factors, potential vegetation types may change over time. Over the next 50 years, certain environmental influences may negatively impact non-forested vegetation condition and forage production. If temperatures continue to increase, there may be changes in vegetation, shifting from more mesic plant associations to more xeric communities, better adapted to the drier sites. Invasive weeds may continue to spread and increase in abundance and density. Timber canopy may continue to close in areas where wildfires or other disturbances do not occur, and some grasslands/shrublands may see additional conifer colonization and shift to a timber-dominated community. Conversely, there is potential that wildfire may play a larger role in shaping vegetation in some areas, perhaps promoting non-forested vegetation communities, particularly given warmer climate regimes. Transitory range acreage will fluctuate: timber stands will become more open due to harvest, insects, and/or fire; with time and succession, overstory canopies will close in once again.

Perennial stream reaches in higher-elevation areas that have well-timbered valley bottoms and ground-water entry will be most resilient to warming conditions and changing weather patterns. Lower elevation stream reaches, lacking riparian shade, containing high sediment loads, with impaired width-depth ratios, and losing flows to groundwater will be the least resilient reaches to changing conditions. Warmer, drier climates will influence species distributions and successional processes in complex and uncertain ways

Studies indicate that 20th century measures of climate, including drought, represent only a subset of the full range of conditions experienced in the past as a result of natural variation. Although drivers and feedback mechanisms are not fully understood, there is sufficient indication from past climate records and future projections to prioritize development of effective strategies for coping with the consequences of more frequent, more severe, and longer drought (USDA Forest Service, 2016).

Although it is difficult to model a detailed picture predicting the occurrence and extent of future drought, higher temperatures will increase severity of drought episodes when they occur. Higher temperatures will reduce soil moisture critical to plant productivity, species composition, and erosion potential (Polley and others 2013). Models of net primary productivity predict overall better growing conditions for the northern Great Plains (Polley and others 2013, Reeves and others 2014) which may have an influence on the Ashland and Sioux Districts.

Drought has always impacted the physical environment and will continue to do so. In the Western United States there is a trend toward dry conditions (USDA Forest Service, 2016). Uncertainty arises primarily from limited capacity to predict future precipitation changes, particularly long-term lapses in precipitation. Despite this uncertainty, there is growing consensus that extreme precipitation events (e.g., lapses in precipitation and more intense storms) will increase in frequency, and warmer temperatures will exacerbate the impacts of drought on forests and rangelands in the future (USDA Forest Service, 2016). Drought in rangelands reduces forage and water available for livestock grazing and wildlife use. Reduced vegetative cover can lead to wind and water erosion. Drought often affects wildfire-related disturbance. In addition, droughts are predicted to accelerate the pace of invasion by some nonnative plant species into rangelands.

A diverse suite of rangeland goods and services that could thrive under a more drought-prone environment needs to be considered. Warmer temperatures will likely result in increased fire frequency and intensity, creating more favorable conditions for invasive species, which would likely decrease overall forage quality and biodiversity. Management schemes will need to continue to be flexible and sensitive to changes in species composition.

Frequent low-severity drought may selectively favor more drought-tolerant species and create rangelands better adapted to future conditions without the need for management intervention. By contrast, severe drought (especially in combination with insect outbreaks or fire), may threaten large-scale changes that warrant substantial management responses. Actions could range from reducing vulnerability, facilitating post-drought recovery, or facilitating a transition to a new condition. Grazing practices need to continue to adapt to changing drought regimes.

Management actions can either mitigate or exacerbate the effects of drought. A first principal for increasing resilience and adaptation would be to avoid management actions that exacerbate the effects of current or future drought. Options can include altering structural or functional components of vegetation, minimizing drought-mediated disturbance such as wildfire or insect outbreaks, and managing for reliable flow of water.

Grasslands and Shrublands. Climate change will affect rangelands because changes in temperature and precipitation affect vegetation growth and distribution. Expected effects on rangeland vegetation are difficult to characterize as a result of uncertainty, regional variability, poorly understood vegetation dynamics, and complicated interactions and feedbacks. However, available research suggest some possible future implications of climate change for rangelands.

Precipitation and temperature have been reliable predictors of the extent and distribution of plant groups (for example, cool-season C3 and warm-season C4 species) across the landscape (Epstein et al. 1997; Knapp et al. 2001). Changes in these drivers have implications for vegetation. Rising carbon dioxide levels may complicate these relationships in the future, however. For instance, warmer and drier conditions should favor C4 grasses (Knapp et al. 2001; Winslow et al. 2003) so that short and tallgrass pine savannas may stand to benefit, but rising carbon dioxide should favor C3 species (Morgan et al. 2004, 2007; Polley et al. 2003, 2006; Reich et al. 2001). Further complicating these relationships are changing temperature and precipitation regimes. Increased variation, intensity, and changes in the timing of precipitation can also influence species composition and productivity of rangelands. For example, as springtime temperatures increase, the extent and magnitude of cheatgrass infestations may increase.

Ellison and Woolfolk (1937) documented the effects of a sustained drought near Miles City, Montana that peaked in 1934; this drought was aggravated by above-average temperatures and preceding years of below-normal precipitation. They documented substantial death of pine, juniper, and cottonwood, but also noted declines in sagebrush and other species. All shrubs experienced considerable dieback. Grass cover was reduced by up to 79 percent depending on the species. Effects of the drought were multiyear despite a favorable season in 1935. Needle-and-thread grass (*Hesperostipa comata*) and Sandburg bluegrass (*Poa secunda*) were able to recover relatively quickly, despite mortality, through the establishment of new seedlings. Stands of big sagebrush experienced considerable mortality and did not regenerate, whereas silver sagebrush (*Artemisia cana*) was able to resprout from the base.

Green Ash Woodlands. The northwestern Great Plains semi-arid environment is marginal for tree growth, and green ash is at the western, most arid margin of its range in eastern Montana. Green ash is primarily a tree of humid to sub-humid climates, occurring mainly in bottom lands, so it is reasonable to assume that hydrology is an important limiting factor for the growth of green ash in eastern portion of the assessment area. In the first decade of the 21st century, winter (December-February) precipitation was approximately 25 percent lower than the 20th century average in southeast Montana. Perhaps more importantly, the winters averaged more than 3 degrees Fahrenheit warmer than in the last century (Lesica and Marlow, 2013). These conditions have probably reduced snow accumulations, early spring flows and the deep water penetration into the soil compared to the past. Hydrologic conditions conducive to recruitment and growth of green ash seedlings in eastern Montana may have been sporadic, even prior to the introduction of Eurasian sod grasses into the woodland understory (Lesica & Marlow, 2013). These conditions may be even less common now in a warmer, drier climate.

An increase of more drought-tolerant, grazing-adapted species and a decline in green ash tree seedling recruitment might be expected with a decrease in precipitation even in the absence of grazing. More open stands are associated with drier sites or regions. It is likely that the future climate of the northwestern Great Plains, in particular, might be characterized by decreases in precipitation and increases in temperature and the frequency of extreme climatic events. Such changes could make recruitment of green ash from seed a rare occurrence in many stands at the arid edge of the tree's geographic range (Lesica and Marlow, 2013).

Cottonwood. Even though cottonwood is a prolific seeder and has high reproductive ability, there have been numerous cases where cottonwood has declined due to mortality of mature trees without adequate regeneration (Rood and Mahoney, 1990; Auble and Scott, 1998; and Lytle and Merritt, 2004). Possible reasons for the decline include changes in hydrologic regime leading to loss of suitable regeneration sites, changes in hydrologic regimes leading to a lower water table and drought induced mortality of establishing seedlings, exclusion of cottonwood by invasive plant species such as salt cedar and Russian olive (Lesica and Miles, 1999 and 2004), and overgrazing pressure by large ungulates and livestock (Rood and Mahoney, 1990). While older cottonwoods survive fire and often produce sprouts, seedlings and saplings are readily killed (Adams et al. 1982).

Alpine. Elevation will play a large role in plant species composition in conjunction with predicted climate change. High elevation, alpine or other fringe type environments may see plant species composition change first (Murphy and Weiss 1992). Invasive plants apparently have not yet become a serious problem in the alpine tundra of the Custer Gallatin National Forest, although yellow toadflax and Canada thistle are present above 9,000 feet and has the potential to invade such areas in the future. Succession occurs very slowly in the alpine tundra and recovery from invasions or human caused disturbances, especially if the soil is degraded, could take a century or more. While little is known about changes through time in the alpine zone, the causes of plant distribution patterns is better known. Johnson and Billings (1962) conducted a study on the effects of processes driven by freezing and thawing on alpine plant distribution on the Beartooth Plateau, and Thilenius and Smith (1985) describe plant-environment relationships on the alpine ranges of the Absaroka Mountains.

Long-term monitoring for some sensitive plant species has indicated population resiliency or stability during the fluctuating climatic conditions that have occurred during the last two decades in the northern Rockies (Shelly, 2012). Peripheral populations to 12 arctic and boreal species were monitored over the last 20 years in Glacier National Park and The Nature Conservancy's Pine Butte Preserve. It was found that of the 20 populations of 12 species monitored, ten populations showed a significant decline; nine were stable; and only one increased (Lesica, 2012).

Sparse Vegetation. Sparsely vegetated habitats are often fragile systems. Although recreation and road or trail construction can be threats to these habitats, disturbance is often limited due to inaccessibility in the landscapes. Threats to the sparsely vegetated habitats on the Sioux and Ashland Districts include weed invasion, trampling from grazing, as well as shifts in warming and/or drying patterns. Shifts in warming or drying trends may also contribute to a change in range and/or distribution of these types.

Plant Materials. Echinacea has the ability to regenerate from the root after a commercial harvest. Echinacea has been observed sprouting after commercial harvest of the top 6 to 10 inches of root material (Kindscher, 2008). Echinacea seeds have been identified in the top half inch of soil after a seven-year drought, suggesting the ability to seed bank. Studies in Montana (during drought conditions) and Kansas indicated that approximately 50 percent of harvested roots resprouted. The length of root harvested significantly affected the ability of the plant to resprout. Those plants that were more shallowly harvested and had less root length removed were more likely to resprout. These data indicate that echinacea stands can recover over time from intensive harvest if periods of nonharvest occur.

Some tribal members have noticed recent shifts in the seasonal availability for plant collections used for traditional purposes (pers. Comm., H. Lapoint) where some plant collection timeframes have shifted earlier than normal. This trend may likely continue.

Fire

General. Future trend in vegetation composition will be greatly influenced by human actions as well as climate influences and natural disturbance processes. Disturbance processes, principally fire, herbivory, and periodic drought (that is, climatic variability) are the principal drivers of vegetation change. Of these, fire is driving factor determining the amount and pattern of forest and non-forest cover.

Fire sets back natural succession at least temporarily, and generally starts succession over again at an earlier seral stage than the vegetation was in prior to the fire. Wildfire will often be a greater disturbance (more often move succession to an early seral stage) than will prescribed fire because planned/managed fires are designed through the burning plan to use certain wind, temperature, and moisture conditions at the time of ignition to achieve specified vegetative conditions as a result of the prescribed fire.

Fire maintains the diversity of vegetation across grasslands, retards or prevents conifer encroachment in meadows and parks, regenerates aspen stands, and is responsible for maintaining the mixture of vegetation necessary on shrublands for wildlife habitat diversity for such species as elk, deer, antelope, sage grouse, and many non-game species.

Fire suppression will likely continue to alter successional processes, generally to favor shade-tolerant species, although vegetation treatments and/or wildfires may mitigate this influence somewhat. Warmer, drier climates will influence species distributions and successional processes in complex and uncertain ways; the possible influence of climate change is discussed in the Climate Change and Baseline Assessment of Carbon Stocks sections of the Assessment. For example, species better adapted to warm, dry conditions such as ponderosa pine may gain a competitive advantage in some areas. Vegetation composition influences, and is in turn influenced by, spatial heterogeneity of landscapes and interrelated ecosystem drivers.

Recent large fires have changed the amount and pattern of forest cover across much of the Ashland and Sioux Ranger Districts and a smaller proportions across the other districts. Even though many areas of forested cover types burned in recent fires, there is only a minor component of that that is considered as transitory rangeland. Transitory rangelands will shift to more grass and forb species and will eventually shift back to shrubs and tree cover over time. This shift back to tree cover is estimated to take about 20 to 80 years plus, depending on the seed source that remains post-fire. North, northeast, and east aspects will likely sprout mesic shrubs with very little grass forage. West, southwest and south aspects will likely express a grass/forb cover longer.

The effects of warmer climate may have been more than counteracted by fire suppression activities in the last century, with the net result being an increase in the frequency of succession from grasslands to shrubland, especially shrublands dominated by mountain big sagebrush. However, there is no evidence to suggest that the shift is large enough to be beyond the natural range of variability. Prescribed burns by forest personnel may be keeping successional patterns in non-forest lands within the range of variability.

Both fire regime and impacts of fire are assessed as part of watershed condition framework. Only 56 (29 percent) of montane and 22 (27 percent) of pine savanna watersheds are within their natural fire regime or within fully functioning condition, if recently burned. One watershed across the Custer Gallatin National Forest was rated as impaired function, with the vast majority (194) of Custer Gallatin watersheds rate as functioning at risk with respect to fire regime.

Riparian. In certain forested riparian areas, fire frequency has generally been lower, and fire severity has been more moderate than in adjacent uplands, but in other areas, fires have appeared to burn riparian areas with comparable frequency. The degree to which fire properties vary from riparian areas to uplands also depends on the topographic continuity of the landscape. In conifer dominated headwater streams, fire properties may be similar in riparian areas and uplands due to small differences in topography, microclimate, vegetation, and fuels (Dwire and Kauffman, 2003). However, marked differences in physical characteristics and fuels may be expected in deep canyons occurring in an otherwise level landscape, or along wide alluvial reaches in mountainous landscapes. In the northern Great Plains, fires were frequent in open grasslands, but thought to occur less frequently in rough and dissected terrain (Higgins, 1984). Under drought conditions, and with the simultaneous occurrence of high temperatures, high wind speeds, and low relative humidity, fire weather would likely override local physical variables as the primary determinant of fire behavior, and fire may behave similarly in riparian areas and in uplands (Dwire and Kauffman, 2003).

Like many upland species, riparian plant species possess natural defense mechanisms to some stressors, such as aspen, cottonwood, green ash, chokecherry, or coyote willow having the ability to sprout after fire or flood (Hansen et al., 1985). These adaptations to disturbances facilitate survival and reestablishment following fires, thus contributing to the rapid recovery of many streamside and seep habitats. Fire in and near riparian areas is an important disturbance element driving ecosystem processes, such as large woody debris recruitment to stream channels, reducing conifer encroachment, and increasing deciduous vegetation. These effects can also provide the basis for beaver colonization

Grasslands and Shrublands. Overall, fire suppression and in some cases grazing, have resulted in an increase in the amount and distribution of conifer colonization into grasslands and shrublands. Sagebrush cover and density has also increased for the same reasons. Grassland and sagebrush communities experienced a reduction in geographic coverage. During pre-settlement times, naturally occurring fire regimes maintained these communities across the landscape. Fire intervals were relatively short resulting in relatively low intensity fires serving to regenerate grass stands, recycle nutrients tied up in older decadent vegetation, and continually removing colonizing coniferous species.

Historic photographs (late 1800s) show that there was much less sagebrush on bunchgrass steppes in northern Yellowstone National Park than in 1970 (Houston 1973) and in some areas on the Bridger-Teton National Forest (Gruell 1980) (although some areas also showed an increase in sagebrush). Fire suppression has resulted in an increase in the density and extent of coniferous forests in southwest Montana (Gilkerson, 1980; Arno and Gruell 1983, 1986; Gruell 1983) and in the Black Hills, South Dakota (Progluske, et al., 1974). Young forests have expanded at the expense of grasslands and sagebrush steppe (Arno and Gruell 1986). Although fire suppression could cause increases in shrub cover and tree colonization, it is possible that the change is not large enough to have exceeded the natural range of variability at the stand or landscape level. Fires are still frequent in non-forested habitats and can burn large areas.

Where big sagebrush is dominant, vegetation changes are dramatic after fire because most species and subspecies of sagebrush are not capable of sprouting (silver sagebrush, however, is a vigorous sprouter following fire). When a fire occurs in big sagebrush types, grasses and forbs become the dominant species until sagebrush re-establishes. Eventually, big sagebrush will re-establish, returning to pre-burn densities after about a decade or more for mountain big sagebrush communities (Blaisdell 1953, Mueggler and Blaisdell 1958; Harniss and Murray 1973) and in excess of 100 years for Wyoming big sagebrush communities (Cooper et al. 2007; Baker, 2006).

Fire suppression could lead to a larger amount of land area in the shrub successional stage than during the historic reference period. Cooper and others (2007) found that livestock grazing does not seem to be casual in the recovery of Wyoming big sagebrush as the only study site without livestock grazing for the entire period after burning had no canopy recovery in 25 years.

Although sagebrush was common prior to European settlement, areas dominated by sagebrush have increased, primarily as a result of fire suppression. Livestock grazing is sometimes implicated in the increase of sagebrush. However, sagebrush has increased at Big Hole Battlefield National Historic Site even though it has been protected from livestock grazing for approximately 50 years (Pierce 1982).

Overall, the fire frequency and extent in mountain and Wyoming big sagebrush today, at both the stand and landscape scales, is probably lower than during the historic period.

Mountain and Wyoming big sagebrush are sensitive to encroachment by conifers; studies have shown that in southwestern Montana, mountain big sagebrush is declining due to competition from Douglas-fir (Gruell et al. 1986; Grove et al. 2005) and Wyoming big sagebrush is declining in the pine savanna units due to competition from ponderosa pine. Douglas-fir and ponderosa pine expansion into grass and shrub communities may in part reflect natural ecotone dynamics, but overgrazing, climate changes, and fire exclusion have likely caused more extensive encroachment than would be present naturally. A study conducted in close proximity to the assessment area found that mountain big sagebrush canopy cover declined from more than 20 percent to less than 15 percent and less than 5 percent as Douglas-fir canopy cover increased beyond 20 percent and 35 percent respectively (Grove et al. 2005). This trend may continue, but may be mitigated by altering grazing or fire suppression activities.

Bitterbrush occurs on the Hebgen Lake District and is an important winter range browse species for big game. The abundance and distribution of bitterbrush is largely influenced by climate and fire regimes. Seed caches from rodents and ants also play a vital role in the dispersal and regeneration of bitterbrush. As a shade intolerant, nitrogen-fixing shrub, it is an early colonizer on disturbed sites in several plant communities (that is, xeric ecotones, shrub-steppe). It competes with nonnative, invasive, annual grasses such as cheatgrass (*Bromus tectorum*), which are spreading rapidly throughout bitterbrush habitat. This invasion has increased fine fuel loads, causing more frequent high severity fires, where bitterbrush, considered a weak sprouter, is often killed. Sprouting ability following fire is influenced by fire severity and season, where bitterbrush may sprout following light-severity fires that occur in spring (FEIS, accessed 2016).

Grasses generally recover well following low to moderate severity fires. Some grasses, such as Idaho fescue, may decline following high severity fires. The outcome after a fire varies depending on species present before the fire. Fire combined with prolonged drought periods can shift the species composition. Studies have documented the return of Echinacea populations, after prescribed fires, from seed developing into seedlings.

Conifer canopy closure, conifer/shrub encroachment into grasslands, and the spread of invasive weeds all have the ability to reduce available forage for livestock and wildlife. The degree to which future management actions address each of these ecological processes will in turn influence the potential loss or increase in available forage. Fire and physical manipulation of the tree overstory, may have potential effects of maintaining or increasing forage productivity for browsing and grazing ungulates.

When large wildfires occur (that is, Ash Creek/Taylor Fork fires in Ashland or the Brewer and Kraft Springs fires on the Sioux District), impacts will occur temporarily. Permit holders may have to find other options for feeding their livestock during post-fire deferment on Forest Service allotments. This holds true during periods of drought as well.

Juniper Woodlands. The abundance and distribution of Rocky Mountain juniper is largely influenced by climate and fire regimes. Juniper tends to become abundant in the later stages of succession in non-forested types, where it slowly becomes established after other grasses and shrubs. Wildfire serves to kill and consume the juniper in these areas as well as where it has developed as a ladder fuel in dry conifer forests. Although it is an important component, in the absence of natural fire juniper is likely more widespread and abundant than it would have been historically. Juniper expansion can lead to the decline of grass and shrublands and result in altered fire regimes.

Fire is a major factor controlling the distribution of Rocky Mountain juniper. Woodlands dominated by Rocky Mountain juniper have increased in density, extent, and age in the past 100 years (Gruell 1983), probably due to fire suppression (Gruell et al. 1985; Arno and Wilson 1986). Reduced fire frequency, and introduction of grazing account for the expansion of juniper woodlands into meadows, grasslands, sagebrush communities, and aspen groves that began in the late 1800s. Prior to this time, more frequent fires probably maintained low density in woodlands and often restricted junipers to rocky sites.

In general, the species grows in areas that do not burn frequently or intensely (FEIS, accessed 2016). Average fire-return intervals at the ecotone between forest and sagebrush grasslands of the high valleys in southwest Montana were 25 to 50 years prior to settlement (Arno and Gruell 1983). Overall, the fire frequency and extent in juniper woodlands today, at both the stand and landscape scales, is probably lower than during the historic period.

Green Ash Woodlands. With fire suppression, fire frequency has declined since settlement. It has been hypothesized that woodlands were less common in pre-settlement times partly as a result of high fire frequency. Green ash woodlands maintain a higher humidity than adjacent grasslands, and fuels are expected to be less combustible. Many woodlands occupy deep ravines or steep slopes with cool aspects that act as natural fire breaks. The pine savanna – green ash woodland ecotones are more likely to experience frequent fire than are wet bottomland deciduous habitats of the montane areas. However, a variety of anthropogenic, climatic, and environmental conditions have affected and continue to affect the fire ecology of green ash habitats. In the Northern Great Plains Pine Savanna settings, fire frequency of these green ash habitats is largely unknown.

Although broadleaf stands and draws of the Northern Great Plains are typically moister, greener, and more humid than surrounding grasslands and forested lands, the narrow size of these draws, coupled with the high frequency of grassland fires before active fire suppression in the area, suggests that fires did burn these areas especially during drought conditions (Sieg, 1997). Other researchers have suggested that green ash and chokecherry habitats are fire adapted because most associated species display some fire tolerance and/or postfire sprouting ability (Hansen et al., 1995). Associated tree and shrub species produce sprouts from the root crown when the main trunk is damaged (Lesica and Marlow, 2013). Based on research that suggested low-severity fires promoted regeneration by thinning stands and promoting sprouting, Lesica (1989) reasoned that some level of fire was important to the maintenance of upland green ash stands in eastern Montana. In a study designed to test his hypothesis, Lesica (2003) found more sprouts, fewer seedlings, and more dead trees on burned sites than on similar nearby unburned sites. All sites burned in wildland fires. The low number of seedlings on burned sites suggested that fire killed green ash seed on or near the soil surface, making seedling recruitment dependent on seed-producing trees, a lot of which were killed by fire. However, green ash sprout production was greater on burned sites suggesting that asexual reproduction may compensate for a temporary lack of sexual recruitment. The green ash community, when maintained by fire, will have a mosaic of different age classes within a watershed. Browse for ungulates can increase and the structural complexity of the community can be maintained.

The distribution and structure of green ash woodlands in the assessment area has been affected by fire exclusion and grazing. Fire exclusion has contributed to expanding stands and density of ponderosa pine with greater competition over green ash and greater risk of stand-replacing fire. Low-elevation ponderosa pine forests of the northern Rocky Mountains historically experienced frequent low-intensity fires that maintained open uneven-aged stands (Sala et al. 2005), but fires today are more often stand-replacing (Pollet and Omni 2002).

The Sioux and Ashland Districts have experienced large scale wildfires in the past 18 years that have affected green ash woodlands. Some stands in the long pines of the Sioux District experienced reburn effects as well (1988 Brewer Fire and 2002 Kraft Springs Fire) setting back recovery. Postfire recovery depends largely on the pre-fire conditions in the ground level understory. Many of these burned stands had enough sod development to impede green ash seedling and sapling establishment that it is unlikely that functional stand conditions will return in these areas. On the other hand, the post-fire conditions in the long pines are showing a large release and increase in aspen stands that were previously not well represented on the landscape in recent history. Where green ash recovery in post burn settings appears to be the best is where there is less sod and more pine litter and duff as seen in the Ekalaka Hills Dugan Fire on the Sioux District.

Aspen. Aspen populations have changed considerably since the beginning of European-American occupancy in the assessment area. Extensive fires during the 1800s appear to have created large stands of aspen, both in Colorado (Veblen and Lorenz 1986) and on the west slope of the Sierra Madre in southern Wyoming (burned in 1841). It is unclear if these large stands developed largely from sprouts (ramets) or seedlings (genets). It is also unclear what trees dominated the vegetation prior to the fires. Aspen occurs on less than 1 percent of the Custer Gallatin, but, where it occurs, fire probably has played a similarly important role in the establishment of new stands (Brown and DeByle 1989, Romme and others 1997).

Mean fire return intervals for aspen groves probably are essentially the same as for the other forest types with which they occur. This is because, while aspen is not considered to be highly flammable, the stands often burn when the adjacent coniferous forests burn (DeByle and others 1987, 1989). Veblen and others (1994) found fire return intervals in aspen forests of 160 and 240 years (mean = 202) in Colorado, which was similar to some nearby conifer stands in the same area. Lightning-caused ignitions in aspen stands are probably rarer than in adjacent coniferous forests. High intensity fires may kill the root systems of some aspen, thus favoring development of conifers (Parker and Parker 1983). However, the relatively mesophytic herbaceous understory in many aspen stands probably results more often in cooler fires than in adjacent stands of conifers. Such fires favor the development of large numbers of aspen root sprouts even though the aboveground part of the older trees (shoots) is killed (Veblen and Lorenz 1991).

The abundance of aspen has fluctuated with the frequency, size, and intensity of fires, although grazers and browsers also may have had an effect. Across the Rocky Mountains, aspen stands are apparently declining in some areas but not in others (Campbell and Bartos 2001, Shepperd and others 2001).

The data that are available suggest seedlings and young sprouts are uncommon, perhaps more so than during the historic period. Fire disturbances during the last century may have enabled the establishment of new groves through seedlings or the regeneration of old groves through root sprouting, but it is difficult to determine if they were previously more or less common because aspen shoots (the ramets) usually live less than about 100 years (in contrast to the root system which lives much longer). Fire suppression during the last 85 years has likely reduced fire frequency and extent below the natural range of variation in some aspen stands (Shepperd and others 2001). Houston (1973) noted apparent declines in aspen to only 2 to 4 percent of his study area in northern Yellowstone National Park, which he postulated was due primarily to fire suppression and secondarily to elk browsing of young root sprouts (Loope and Gruell 1973, Kay 1990). A cursory survey on the Custer Gallatin National Forest shows conifers are slowly replacing the seral aspen stands in a number of areas, probably more than would have occurred without fire suppression. Overall, similar to low-elevation coniferous forests, the fire frequency and extent in aspen today, at both the stand and landscape scales, is probably lower than during the historic period.

Aspen is less common than it was historically because of encroachment and overtopping by conifers, overgrazing by cattle and large native herbivores, and the absence of fire (Shepperd et al. 2001; Kaye et al. 2005). Without periodic disturbance, seral aspen may eventually disappear and be replaced by shade tolerant conifers (Shepperd 1996). Aspen clones that do sprout can be impacted by big game and livestock because the suckers are a desirable food source. Reductions of aspen forests are believed to be largely due to fire suppression activities over the past 100 years.

Aspen-dominated woodlands can be relatively stable depending on site conditions and historical factors (Reed 1971; Mueggler 1985; Bartos and Campbell 1998). Where seral to conifers, a few aspen usually persist in the understory of coniferous forests and rapidly produce an abundance of new sprouts over large areas when the next stand-replacing disturbance occurs. Many new stands of aspen “ramets,” that part of the clone that most people think of as the aspen plants (trees), are produced in this way. A single clone of aspen can be large with thousands of sprouts, covering about two and a half or more acres, and is thought to be very long-lived, perhaps thousands of years—though individual ramets produced in the clone often do not live more than 100 or 125 years (Myers et al., 2006). Notably, while young aspen shoots within a clone share the same root system with the mature canopy dominants, they typically are unable to survive in the forest understory environment.

The mountain pine beetle outbreak across many of the landscape areas has reduced competition to some aspen in pine stands, and could potentially allow them to increase in extent and vigor. Potential wildfires could both kill existing aspen stems and also stimulate new suckering that could increase the vigor and extent of aspen. When overstory stems are killed thousands of suckers sprout from the original root system and grow rapidly to form a new stand (Shepperd 1996). A stand-replacing wildfire would likely promote aspen regeneration, although other factors such as insects, disease, animal herbivory, and genetics also play a role in the long term success of aspen (Shepperd 2001). The influence of a warming climate might be to increase the extent and severity of disturbances which could reduce the cover of conifers and promote aspen in some cases. However, dry conditions may also render some sites unsuitable for aspen.

Alpine and Sparse Vegetation. Disturbance from fire is generally very limited due to its inherent low fuel load setting.

Herbivory

Herbivory is a disturbance agent in non-forested systems. Its effect on succession depends on a number of factors including the level of grazing, timing, frequency, kind of herbivore, and existing seral condition of the vegetation. Grazing and browsing by livestock, big game animals, and other wildlife have similar effects.

Grazing

Bison were common before settlement, and the density of cactus and lack of grass reported by explorers and trappers suggests that grazing was severe in some areas (Lesica and Cooper, 1997). By the middle of the 19th century, bison were exterminated, and domestic cattle replaced them as the primary grazers. In the latter part of the century, livestock grazing was also severe up until the crash of the industry following the winter of 1887 (Phillips 1957). Lesica and Cooper (1997) found no evidence that livestock grazing had any greater impacts on the upland vegetation than grazing by bison and that there may be more grass now than before settlement or the end of open range. However, some of the changes in riparian or terrace vegetation in the past 100 to 150 years may be due to differences in grazing behavior between bison and cattle. Early descriptions of bison grazing in southwestern Montana suggest that they spent little time in riparian areas but grazed primarily in the uplands. On the other hand, domestic livestock, spend a good deal of time grazing in riparian areas during summer. Declines in some willows may also be partly attributed to livestock grazing (Clary et al. 1992, Schulz and Leininger 1990).

Currently, approximately 22 percent of the Custer Gallatin National Forest consists of primary rangeland where permitted livestock generally graze (8 percent of the montane units and 86 percent of the pine savanna units); conversely about78 percent of the Custer Gallatin National Forest currently do not have impacts associated with permitted livestock use. Current prescribed stocking rates, use levels, season of use, and duration of use are well below what existed before the establishment of the Custer and Gallatin National Forests. As an example, a summary of historic grazing records for the Pryor Mountains indicate that current forage offtake by permitted livestock is about 14 percent of the use that was occurring in the early 1900s. During the 40s to 60s, stocking rates were reduced, seasons of use were shortened, and cross-fencing for pasture rotation and increased opportunity for rangeland recovery occurred. Further seasonal restrictions occurred to improve entry dates relative to rangeland readiness. Based on monitoring, other more recent stocking rate reductions have been implemented on several allotments, typically ranging from 10 to 30 percent and as high as 50 percent.

Since the 1986 Forest Plan timeframe, animal unit months permitted on the Custer Gallatin have decreased 23 percent. Animal unit months permitted on the Gallatin portion of the Custer Gallatin National Forest have decreased 42 percent and animal unit months permitted on the Custer portion have decreased 19 percent. The changes in Gallatin units were primarily due to allotment closures of long-standing vacant allotments (see the Permitted Grazing Report for detailed information on allotment closures), as well as some stocking rate adjustments. The changes in the Custer units were primarily made to respond to range readiness issues and carrying capacity and stocking rate issues.

For a variety of reasons, 59 allotments (primarily cattle) have been formally closed on the Gallatin portion of the Custer Gallatin National Forest since the 1986 Forest Plans. Nine of the 59 closures were done through decisions made in the 1986 Forest Plan while the remaining 50 have been closed since then. Closures were typically done after years of allotments being vacant and were based on allotment viability, logistics, and economics of operations, limited access, ownership changes from land exchanges, failing infrastructure, grizzly bear conservation, and other wildlife considerations (See the “Grazing” section of the assessment for closure locations and further detail).

High historic levels of grazing use across the Custer Gallatin National Forest a century ago were responsible for maintaining large acreages in early to mid-seral condition and for over-utilization in many areas. Reductions of grazing use over the last several decades has helped to contribute to improvement of primary rangelands.

Properly managed by vegetative type and within habitat capacities, use by ungulates tends to utilize, and provide for, a mix of seral stages across broad landscapes. High intensity of use, repeated use during times of rapid plant growth, frequent use of individual plants or plant communities, or longer periods of use tend to push more of the vegetation toward the early-to-mid stages while lighter, shorter, or less frequent use tends to result in a higher percentage of mid and late seral vegetation.

Browsing and grazing of mesic shrubs and deciduous broadleaf seedlings can be detrimental to successful stand maintenance. Some areas may need to be fenced, depending upon extent and location of burned or treated areas or otherwise managed to control use by cattle until the young trees are big enough to avoid being detrimentally grazed, generally to six feet tall.

Big game populations, however, are less manageable or predictable, but their effects on managing for desired seral stage are similar. Higher numbers of big game species will move or maintain more acres of rangeland vegetation to an early or mid-seral condition (elk in the meadows and more open grassland types, deer and antelope in shrublands and grasslands and riparian areas, and moose in riparian and wetland habitats like willow stands); lower numbers allow more acres to move to a higher seral stage.

In addition, seasonal use, such as big game moving up the mountain very early following green-up each year, hits plants when they are most vulnerable and can set back succession and can damage wet soils. In the same way, seasonal and intense use on palatable shrubs such as willow can retard succession and result in undesirable vegetative or soil conditions.

Currently, all big game populations are continuing a trend of increasing in numbers, and elk on the Ashland and Sioux Districts, in particular, are well above historic levels. Wintering populations of a variety of wildlife species in the Gardiner Basin are creating high use levels on some areas of winter range that in turn result in heavy use of riparian areas, and hay fields on deeded lands below the Forest. There is potential for further grazing pressure in the north and west bison tolerance zones on the Gardiner and Hebgen Lake Districts.

Beaver

Beaver are key agents of riparian-wetland succession because the dams they build act as hydrologic modifiers. When a beaver dam is constructed, a flowing stream can be changed to an aquatic pond. This in turn can lead to aggradation of the channel, establishment of floodplains, and raising groundwater levels. Elevated water tables also help to keep water in areas that would be otherwise dry during summer months and also during times of drought. This helps to sustain plant and animal life and has been shown to increase productivity of a variety of species (Bouwes et al. 2016).

Riparian shrublands across wide, flat valley bottoms typically occupied by dense willow or riparian shrub cover has often been associated with beaver activity where the slope is sufficient (for example, 2 to 3 percent) to move water through the system of stable dams. Generally, there is little herbaceous undergrowth due to the high shrub canopy cover. Associated community types include all tall and low willow types, alder, birch, redosier dogwood, and hawthorne, etc. (Hansen et al. 1995). Other deciduous broadleaf riparian shrubs and trees also contribute material and food needed for beaver habitat. There are ongoing beaver relocation projects within the Ashland and Sioux areas that have resulted in the establishment of dams and improved riparian conditions in some areas.

Historically, riparian communities developed in close proximity to water and were more extensive (structurally and geographically) than those which currently exist. Beavers were instrumental in the creation and maintenance of willow, alder, birch, and aspen stands. Water table during historical times were much closer to the surface due to the creation of beaver ponds therefore, soil moisture was more available to support extensive stands of riparian vegetation. Wildlife, primarily bird species, which are tied to riparian communities were probably maintained at a higher population level than those currently documented. In some locations, historic floodplains now appear as dry upland benches which supports little if any riparian vegetation. See the Aquatic and Riparian Report for further detail.

The scarcity of cottonwood early in the 19th century appears to be due to beaver (Lesica and Cooper, 1997). By the middle of the century beaver populations had been greatly reduced by trapping, and cottonwoods were able to mature in many riparian areas. Extensive stands originating during the last 100-150 years are now declining. These declines may, in part, be a natural result of age. However, decline and an apparent lack of adequate recruitment along some reaches is probably a result of diversion and impoundment (Lesica and Cooper, 1997) and domestic and wild ungulate browsing effects.

The near elimination of beaver not only affected the storage and release of water in streams, but also resulted in changes in the riparian vegetation. As dams broke and water tables lowered, vegetation once associated with saturated soils (i.e. willows) began to die out. This in turn allowed for greater penetration of the streamside zone by livestock which accelerated the decline in woody vegetation by browsing and structural damage.

Willows dominated riparian areas along smaller order streams. Beaver decreased willow abundance, but they increase available willow habitat by raising the water table over substantial areas. The decline of beaver due to trapping in the late 19th century likely caused a decline in willows in headwaters areas (Lesica and Cooper, 1997).

Beaver populations have declined across much of the assessment area due reductions in woody forage species from livestock grazing impacts, road construction, and access related activities. Fire suppression is also a factor as riparian areas can convert from the cottonwood, aspen, green ash, and willow species preferred by beavers towards coniferous tree species under the prolonged absence of fire. This reduction in beaver populations and activities creates an altered system that is less able to absorb or compensate for factors that add stress to aquatic systems. Trapping was likely a factor in beaver decline along individual streams, but habitat degradation would often need to be addressed before recolonization would occur.

Insect Outbreaks

Grassland and shrubland ecosystems worldwide are prone to infrequent and periodic outbreaks of native insect herbivores and are a natural part of these ecosystems. Grasshoppers and Mormon crickets are the most common types which contribute significantly to the structure and function of grasslands and other rangelands (Branson and others 2006). These outbreaks occur periodically on the Custer Gallatin National Forest. The outbreaks can be anywhere from unnoticeable to exceeding 200 insects per square yard. The outbreaks tend to be more prevalent during periods of drought. Grasshopper outbreaks can have severe economic impacts on the grazing industry, especially during periods of drought when available forage is already scarce (Hewitt and Onsager 1983). In general, since most insect infestations are short-lived (a year or maybe two in the same area), the effects on rangeland vegetation are a defoliation (partial or complete) of the current year's plant growth, but vegetative community succession is seldom affected.

Climate, especially drought, is thought to play a key role in outbreaks of grasshoppers and other insect species on rangelands, but the underlying mechanisms are poorly understood (Capinera and Horton 1989, Gage and Mukerji 1977, Kemp and Cigliano 1994, White 1976). Drought can have both direct effects on the growth and survival of insects and also indirect effects via changes in food quality and susceptibility to disease.

Non-severe drought and warm temperatures generally have a positive effect on grasshopper populations. Warm, dry weather in winter and early spring can lead to increased survival, early egg hatch, and faster population growth; warm, dry weather in the fall can extend the life of females and allow them to produce and lay more eggs (Joern and Gaines 1990, Kemp and Sanchez 1987). Moreover, grasshoppers often prefer to feed on drought-stressed plants, partly due to drought-induced changes in plant chemistry (Bernays and Lewis 1986, Haglund 1980, Lewis 1982). Drought could further promote grasshopper populations by reducing incidence of disease, especially due to fungi as many fungi require moisture (Hajek and St. Leger 1994, Streett and McGuire 1990). However, extreme or prolonged drought can negatively affect grasshoppers through desiccation (especially eggs) or by killing their food plants (Farrow 1979, Joern and Gaines 1990, Mukerji and Gage 1978). Therefore, short-term, less severe droughts can increase grasshopper outbreaks, but longer term, severe droughts will likely have a strong negative effect on grasshoppers and rangeland and grassland biodiversity in general (Kemp and Cigliano 1994, Tilman and El Haddi 1992).

Grasshoppers and Mormon crickets are always present in any given year, but populations change in terms of relative abundance on the landscape. Outbreaks have been known to occur. There has not been any recent insecticide spraying by the Animal and Plant Health Inspection Service to control and reduce grasshopper or Mormon cricket populations on the Custer Gallatin National Forest.

Key Findings

About 70percent of the Custer Gallatin National Forest lies within some type of designated area including wilderness, inventoried roadless areas, research natural areas, and wilderness study area. Special area designations tend to reduce the amount of human-caused disturbances, so generally succession of the included non-forested vegetation tends to proceed toward late seral conditions in these areas (barring setbacks from natural disturbance). Wilderness areas, wilderness study areas, and research natural areas are generally managed to promote "natural" succession and disturbances.

Because of a unique convergence of three floristic and related climatic provinces, the Pryor Mountains are considered a "botanical hotspot", rich in species and community diversity. This area has been found to have high levels of endemism where plant species that are globally rare are found only in the Pryor Mountains and Bighorn Basin area.

The Sioux, Northern Cheyenne, Crow, Bannack, Shoshone, Nez Perce, Flathead, and Kootenai Tribes have affiliations with plant material collections in the assessment area. There are many plant species that have traditional uses as food, medicines, industrials/utility (paint, dyes, traps, etc.) and rituals (that is, incense; sweat lodge construction). Tribal members used trees, shrubs, and grasses as part of their survival and knowledge about their use has been handed down through generations. They have developed strong spiritual relationships with plants. Other plants that are periodically gathered are edible, have medicinal uses, or have utilitarian uses as well. Some tribal members have noticed recent shifts in the seasonal availability for plant collections used for traditional purposes where some plant collection timeframes have shifted earlier than normal. This trend may likely continue.

The assessment area key ecosystem components are comprised of good ground cover and diverse species richness, life forms, cover types, and successional stages. While grasslands and sparsely vegetated areas (that is, badlands, talus, scree, rocky, or exposed areas) are more common non-forested vegetation types in the assessment area (18 percent and 12 percent, respectively), other communities and special habitats are rare and also important components of the overall ecosystem composition of the assessment area (alpine vegetation 4 percent, riparian vegetation 3 percent, shrublands 2 percent, with green ash woodlands, juniper woodlands, limber pine woodlands, aspen and cottonwood each being less than 1 percent of the assessment area).

However, establishment and spread by aggressive non-native invasive plants is one of the greatest threats to the ecosystems in Custer Gallatin National Forest. In general, the presence of invasive plants is likely to push many vegetation and soil variables beyond their natural range of variability. Non-native invasive plants have the potential to alter ecosystems by outcompeting and displacing native plants. Invasive plants have been found to impact wildlife habitat by decreasing the amount of forage, change fire frequency by forming dense stands of flashy fuels, and change soil characteristics by altering soil nutrients. Presence and abundance of invasive plants are a key indicator of condition in grasslands, shrublands, open canopied woodlands and riparian which covers about 1.8 million acres of the assessment area. These ecosystems, covering 53 percent of the assessment area, are vulnerable to aggressive invasive plant establishment and spread. Inventoried acreage infested by invasive plants has doubled over the past 10 years. There is now a footprint of about 58,000 acres of weeds and weed seeds on the Custer Gallatin. Available resources have only allowed weed treatment annually on about 3,000 to 4,000 acres. Warmer/drier climate trends are predicted to accelerate the pace of spread by invasive plant species. Anticipated higher fire occurrence and resulting fire effects is also likely to accelerate the pace of spread by invasive plant species. With projected increasing average annual temperatures over the coming decades coupled with continued and/or increasing drought will likely further invasive weed spread along with increase in abundance and density. As springtime temperatures increase, the extent and magnitude of cheatgrass infestations may increase. Continued weed treatment emphasis along spread vectors (predominantly along travel routes) and in rare and/or special habitats is needed (that is, big game winter ranges, greater sage-grouse habitat, research natural areas, special interest areas, wilderness study areas, wilderness areas). Invasive plants have not been a serious problem in the alpine tundra of the Custer Gallatin National Forest, although a minor amount of yellow toadflax and Canada thistle are present above 9,000 feet and has the potential to invade such areas in the future.

Where projects have been developed to conserve areas or to restore areas, local conditions might be expected to improve, and these areas can move closer to desired conditions. However, external factors such as climate trends, fire, floods, invasive species spread, and drought can be assumed to continue to exert stress on these areas.

Considerable natural variation in climate occurred historically and will continue. Different climate models project differing rates of change in temperature and precipitation because they operate at different scales, have different climate sensitivities, and incorporate feedbacks differently. However, climate models are unanimous in projecting increasing average annual temperatures over the coming decades. Continued or increasing drought will likely further limit the productivity of sites resulting in altered composition, structure, or even lifeform (grass/shrub versus forest vegetation). If temperatures continue to increase, there may be changes in vegetation, shifting from more mesic plant associations to more xeric communities, better adapted to the drier sites.

It is likely that the future climate of the northwestern Great Plains, in particular, might be characterized by decreases in precipitation and increases in temperature and the frequency of extreme climatic events. An increase of more drought-tolerant, grazing-adapted species and a decline in green ash tree seedling recruitment might be expected with a decrease in precipitation even in the absence of grazing. More open stands are likely to be associated with drier sites. Such climatic trends could make recruitment of green ash from seed a rare occurrence in many stands at the arid edge of the tree's geographic range. However, sprouting would likely still occur.

Overall, fire suppression, and in some cases grazing, have resulted in an increase in the amount of distribution of conifer colonization into grassland, shrublands, and broadleaf woodlands such as green ash and aspen. Without periodic disturbance, these cover types may be replaced by conifers. Mountain and Wyoming big sagebrush are sensitive to colonization by conifers; studies have shown that in southwestern Montana, mountain big sagebrush is declining due to competition from Douglas-fir and Wyoming big sagebrush is declining due to competition from ponderosa pine. Douglas-fir and ponderosa pine expansion into grass and shrub communities may in part reflect natural ecotone dynamics, but past overgrazing, climate changes, and fire exclusion have likely caused more extensive colonization than would be present naturally. In the absence of natural fire juniper is likely more widespread and abundant than it would have been historically. Juniper expansion can lead to the decline of grass and shrublands and result in altered fire regimes.

The distribution and structure of green ash woodlands in the assessment area has been affected by fire exclusion and grazing. Fire exclusion has contributed to expanding stands and density of ponderosa pine with greater competition over green ash and greater risk of stand-replacing fire. Low-elevation ponderosa pine forests of the northern Rocky Mountains historically experienced frequent low-intensity fires that maintained open uneven-aged stands, but fires today are more often stand-replacing fires. About 25 percent of the Ashland's and 16 percent of the Sioux's green ash woodlands are mixed forest and mixed savannah dominance types which may be indicative of ponderosa pine colonization into those green ash woodlands.

There is potential that wildfire may play a larger role in shaping vegetation in some areas, perhaps promoting non-forested vegetation communities, particularly given warmer climate regimes. Warmer temperatures will likely result in increased fire size and severity, creating more favorable conditions for invasive species, which would likely decrease overall forage quality and biodiversity. Grasses generally recover well following low to moderate severity fires. Some grasses, such as Idaho fescue, may decline following high severity fires. The outcome after a fire varies depending on species present before the fire. Fire combined with prolonged drought periods can shift the species composition and increase invasive weeds.

The Sioux and Ashland Districts have experienced large-scale wildfires in the past 18 years that have affected green ash woodlands. Some stands in the long pines of the Sioux District experienced reburn effects as well (1988 Brewer Fire and 2002 Kraft Springs Fire) setting back recovery. Postfire recovery depends largely on the pre-fire conditions in the ground level understory. Many of these burned stands had enough sod development to impede green ash seedling/sapling establishment and it is unlikely that functional stand conditions will return in these areas. On the other hand, the post-fire conditions in the Where green ash recovery in post burn settings appears to be the best is where there is less sod and more litter and duff.

Due to large scale wildfires, the long pines on the Sioux District are showing a large release and increase in aspen stands that were previously not well represented on the landscape in recent history.

Mountain big sagebrush and Wyoming big sagebrush are important components of the greater sage-grouse core (priority) and general habitats in the assessment area. Mountain big sagebrush, located on the montane units, is easily killed by fire and often requires ten to 35 years or longer to reestablish to pre-burn stature and density. Wyoming big sagebrush is located predominantly on the Sioux and Ashland Districts with minor amounts on the Beartooth. This species may require in excess of 100 years to reestablish to pre-burn stature and density. The approximate 2,200 acres of core (priority) greater sage-grouse habitat is found along the lower elevation fringes of the Sioux District. Three hundred and sixty-four acres of this core Wyoming big sagebrush habitat (16 percent) recently experienced low severity wildfire effects likely causing some mortality, but less than what would be expected in moderate to high burn severities. Of the approximate 123,400 acres of the general greater sage-grouse habitat found in the assessment area, approximately 13,800 acres (11 percent of the general habitat) recently experienced moderate to high mortality of Wyoming big sagebrush due to a mix of moderate and high severity wildfire effects. Recovery rates to pre-fire densities are expected to be slow. In the montane units, minor amounts of mountain big sagebrush mortality was caused from mixed severity fire effects on general sage-grouse habitat The recovery projections for these habitats are expected to be faster than Wyoming big sagebrush burned areas found on the Ashland and Sioux Districts.

About 2,200 acres of core (priority) greater sage-grouse habitat is found at the lower elevation fringes of the Sioux District. About 123,400 acres of the general greater sage-grouse habitat is found in the assessment area. About 100 percent of core and about 88 percent of the general habitats are found within grazing allotments. The existing condition of grassland and shrublands, including greater sage-grouse core and general habitats, varies across the landscape. In general, they have shown improvement over time with the advent of cross-fencing to move most units from season long to rotation grazing, installing offsite water developments (away from riparian and hardwood draw areas), having improved range readiness entry dates, and shorter duration grazing with more opportunity for plant recovery. In addition, several stocking rate reductions have also occurred over time. This is not to discount that there continues to be some areas where issues are still being assessed and managed. Prescribed burning for increased forage and palatability in sagebrush habitats essentially ceased several years ago given the increased importance of these cover types for not only sage-grouse but for other considerations such as mule deer winter range. There continues to be a need for improved grazing practices and monitoring in these areas.

About 78,000 National Forest System acres (3 percent) of riparian and wetlands occur in the assessment area. As a rare and biologically important landscape component, riparian vegetation should be managed to provide shade, to maintain streambank stability and in-stream cover, and to promote filtering of overland flows. Of 273 watershed condition framework-rated watersheds forestwide, 19 percent of the watersheds' riparian vegetation condition component rated as functioning at risk, with the remainder rated as functioning properly. At the allotment scale, the same overall pattern was seen as at the watershed scale where 71 percent of the riparian survey sites in allotments were found to be in proper functioning condition, with 27 percent functioning at risk and 2 percent were rated as non-functional. The at risk and non-functional sites are largely a function of legacy issues, including roads, uncharacteristic wildland fire, developed recreation, dispersed recreation, historically unmanaged grazing by livestock, and water development and diversion on and off National Forest System lands. In general, the trend for all riparian areas is up from a long-term perspective due to decreases in stocking rates over past decades, rest due to periodic non-use, and natural recovery from past wildfire events. However, the current trend for most reaches are considered not apparent. There continues to be a need for improved grazing practices and monitoring in riparian areas along streams and in wetlands.

About 11,400 acres (National Forest System) of green ash woodlands occurs on the Ashland and Sioux Districts. As a rare and biologically important landscape component, green ash woodlands should be managed to maintain or perpetuate a network of multi-layer and multi-age class of herbaceous plants, shrubs, and trees. Green ash is on the western and most arid margin of its range on the Ashland and Sioux Districts and is likely at the limit of its environmental tolerances. Because of this, extended periods of drought may have an adverse effect on regeneration and probably promote other problems. The current condition of green ash draws may be more a reflection of past (1880 to 1930) grazing pressure than recent livestock grazing and wildlife use. Within primary rangelands of permitted livestock allotments on the Sioux and Ashland Districts, 19 percent of inventoried green ash woodlands are functional, 61 percent are at risk, and 20 percent are non-functional. The at risk and non-functional sites are largely a function of legacy issues due to woodcutting, grazing, deer browsing, introduction of invasive, rhizomatous sod grasses (that is, Kentucky bluegrass), and periods of prolonged drought. Tree recruitment is reduced by competition with sod grass. There continues to be a need for improved grazing practices and monitoring in green ash woodlands.

Information Needs

Forest Plan Information Needs: None identified.
Long-term Information Needs: Vegetation classification and ground cover information for non-forested habitat types in the R1 summary database is being developed and was not available at the time of the assessment. Additional query tools in the R1 summary database could enhance our ability to estimate forb, grass, shrub, and ground cover on meaningful ecosystem types to better depict the health and condition of these types.

To refine the understanding of potential plant communities associated with non-forested ecosystems ecological site descriptions and associated state and transition models should be developed in coordination with sister agencies (Bureau of Land Management and Natural Resources Conservation Service) per policy.

References

General

Barber, J., R. Bush, D. Bergland. 2011. The Region 1 Existing Vegetation Classification System and its Relationship to Region 1 Inventory Data and Map Products. 39 pp.

Biswas, T. J. DiBenedetto, S. Brown, A. Yeager, R. Hamilton, H. Fisk. 2012. Procedures for Mapping Rare Vegetation Types Using Mid-Level Vegetation Maps. RSAC-10005-RPT1. Remote Sensing Applications Center (RSAC). 13 pp.

Branson, F.A., G.F. Gifford, K.G. Renard, and R.F. Hadley. 1981. Rangeland Hydrology. Society for Range Management, Denver, Colorado, Second Edition. Pp. 340.

Chambers, J.C.; D.A. Pyke, J.D. Maestas, M. Pellant, C.S. Boyd, S.B. Campbell, S. Espinosa, D.W. Havlina, K.E. Mayer, A. Wuenschel. 2014. Using resistance and resilience concepts to reduce impacts of invasive annual grasses and altered fire regimes on the sagebrush ecosystem and greater sage-grouse: A strategic multi-scale approach. Gen. Tech. Rep. RMRS-GTR-326. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 73 p.

DeVelice, R.L. and P. Lesica. 1993. Plant community classification for vegetation on BLM lands, Pryor Mountains, Carbon County, MT. Montana Natural Heritage Program, Helena, 78 pp.

Enderlin, H. C., and Markowitz, E. M. (1962). “The classification of the soil and vegetative cover types of California watersheds according to their influence on synthetic hydrographs.” Presentation at Second Western National Meeting of the American Geophysical Union at Stanford University, Dec 27-29, 1962. 5pp with attachments.

Gabel, Mark, B.E. Nelson, D. Mergen, K. Hansen and G. Kostel. 2014. The Flora of Harding County: A Century of Botany in Northwestern South Dakota, USA. Proceedings of the South Dakota Academy of Science, Vol. 93 (2014).

Girard, M. 1989. Native Woodland Ecology and Habitat Type Classification of Southwestern North Dakota. Res. Pap. 281. USDA, Forest Service, Rocky Mountain Forest and Range Exp. Sta., Fort Collins, CO. 36 pp.

Girard, M. D.L. Wheeler, and S.B. Milles, 1997. Classification of Riparian Communities on the Bighorn National Forest. USDA Forest Service, Bighorn National Forest, Sheridan, WY. Unpublished. 352 pp + appendices.

Hanna, D. and P. Lesica. 2012. South Pryor Mountains Important Plant Area. Montana Native Plant Society. Letter to Custer National Forest and IPA Nomination Information. 6 pp.

Hansen, P.L, R.D. Pfister, K. Boggs, B.J. Cook, J. Joy, and D.K. Hinckley. 1995. Classification and Management of Montana’s Riparian and Wetland Areas. Montana Forest and Conservation Experiment Station. Miscellaneous Publication No. 54. School of Forestry, University of Montana, Missoula, MT 646 pp.

Hansen, P.L., and G.R. Hoffman. 1988. The vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest: a habitat type classification. General Technical

Report RM-157. Ft. Collins, CO, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Heinze D.H. and M. Taylor. 1994 Pryor Mountain Desert. A Montana Native Plant Society Naturalist's Guide. 64pp.

Jensen, M.E., J.P. DiBenedetto, and F. Heisner. 1992. An Ecological Classification for the Little Missouri National Grasslands. Missoula, MT: USDA, Forest Service, Northern Region.

Klein, R. 2000. Medicinal Plants of Montana and Harvest Potential. Sweetgrass School of Herbalism, Bozeman, MT. 5 pp.

Leppig, G. and J. White. 2006. Conservation of Peripheral Plant Populations in California. Madron O, Vol. 53, No. 3, pp. 264–274.

Lesica, P. 2012b. The Pryor Mountains. A Botanical Hotspot. Paper presented by the Pryors Coalition at http://www.pryormountains.org/natural-history/botany/botanical-hot-spot/

Marshall, J. K. (1973) Drought, land use and soil erosion, in Lovett, J. V. (ed.) The Environmental, Economic, and Social Significance of Drought, Sydney, Angus and Robertson, Publishers, 55-77.).

Packer, P.E., 1963. Soil stability requirements for the Gallatin Elk Winter Range. J. Wildl. Manage. 27, 401–410.

Pfister, Robert D.; Kovalchik, Bernard L.; Arno, Stephen F.; Presby, Richard C. 1977. Forest habitat types of Montana. Gen. Tech. Rep. INT-GTR-34. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 174 p.

Progluske, R. R. and Sowell, R. H., 1974. Yellow Ore, Yellow Hair, Yellow Pine: A Photographic Study of a Century of Forest Ecology. Bulletins. Paper 621. http://openprairie.sdstate.edu/agexperimentsta_bulletins/621

Reid, K, D. Sandbak, A. Efta and M. Gonzales. 2016. Vegetation Groupings for CGNF Plan Revision and Metadata for Adjustments made to VMAP. Unpublished document. 41 pp.

Walford, G., G. Jones, W. Fertig, S. Mellman-Brown, K. Houston. 2001. Riparian and Wetland Plant Community Types of the Shoshone National Forest. Gen. Tech. Rep. RMRS-GTR-85. Ogden, UT: USDA, Forest Service, Rocky Mountain Research Station. 122 p.

Pre-settlement

Arno, S. F. and G. E. Gruell. 1983. Fire history at the forest-grassland ecotone in southwestern Montana. Journal of Range Management 36(3): 332-336.

Arno, S. F. and G. E. Gruell. 1986. Douglas-fir encroachment into mountain grasslands in southwestern Montana. Journal of Range Management 39(3): 272-275.

Gilkerson, M. 1980. Historical comparison photography. Mountain foothills, Dillon Resource Area. USDI Bureau of Land Management, Billings, MT.

Gruell, G. E. 1983. Fire and vegetative trends in the Northern Rockies: interpretations from 1871-1982 photographs. USDA Forest Service General Technical Report INT 158, Ogden, UT.

Lesica, P. and S. V. Cooper. 1997. Presettlement vegetation of southern Beaverhead County, Montana. Unpublished report to the State Office, Bureau of Land Management and Beaverhead-Deerlodge National Forest. Montana Natural Heritage Program, Helena, MT. 35 pp.

Riparian

Biswas, T.; DiBenedetto, J.; Brown, S.; Yeager, A.; Hamilton, R.; Fisk, H. 2012. Procedures for mapping rare vegetation types using mid-level vegetation maps. RSAC-10005-RPT1. Salt Lake City, UT: U.S. Department of Agriculture, Forest Service, Remote Sensing Application Center. 9 p.

Bouwes, N., N. Weber, C. E. Jordan, W. C. Saunders, I. A. Tattam, C. Volk, J. M. Wheaton, and M. M. Pollock. 2016. Ecosystem experiment reveals benefits of natural and simulated beaver dams to a threatened population of steelhead (*Oncorhynchus mykiss*). Scientific Reports 6, 28581; doi: 10.1038/srep28581.

Clary, W. P., E. D. McArthur, D. Bedunah and C. L. Wambolt (eds.). 1992. Symposium on ecology and management of riparian shrub communities. U. S. Forest Service General Technical Report INT-289.

Elmore, W. and R.L. Beschta. 1987. Riparian Areas: Perceptions in Management. Rangelands. Vol. 9, No. 6, December, 1987. pp 260-265.

Manning, Mary 2009. Note for Non-Forest Habitat Type Groups from May 5, 1999 Workshop. USDA Forest Service, Region 1, Internal Working Document.

Montana Natural Heritage Program. 2016. National Wetland Inventory. Data accessed in 2016. http://mtnhp.org/nwi/

Prichard, D., F. Berg, W. Hagenbuck, S. Leonard, M. Manning, R. Leinard, and J. Staats. 2003. Riparian area management: a user guide to assessing proper functioning condition and the supporting science for lentic areas. TR 1737-16. Bureau of Land Management, BLM/RS/ST - 99/001+1737+REV03. 110 pp.

Prichard, D., J. Anderson, C. Correll, J. Fogg, K. Gebhardt, R. Krapf, S. Leonard, B. Mitchell, and J. Staats. 1998. Riparian area management: a user guide to assessing proper functioning condition and the supporting science for lotic areas. TR 1737-15. Bureau of Land Management, BLM/RS/ST-98/001+1737. 136 pp.

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO. Chpt 5, page 6.

Schulz, T. T. and W. C. Leininger. 1990. Differences in riparian vegetation structures between grazed areas and exclosures. Journal of Range Management 43: 295-299.

U.S. Department of Agriculture, Forest Service. 1986a. Custer National Forest Plan.

U.S. Department of Agriculture, Forest Service. 1986b. Gallatin National Forest Plan.

Grasslands

Axelrod, D.1. 1985. Rise of the grassland biome, central North America. The Botanical Review 51:162-201.

Bailey, J.F, M.B. Richards, V.A. Macaulay, LB. Colson, LT. James, D.G. Bradley, R.E.M. Hedges, and B.C. Sykes. 1996. Ancient DNA suggests a recent expansion of European cattle from a diverse wild progenitor species. Proceedings of the Royal Society of London 263: 1467-73.

Biondini, M.E., AA Steuter, and R.G. Hamilton. 1999. Bison distribution in fire-managed remnant Pine Savannas. Journal of Range Management 52:454-61.

Bogucki, P. 1996. The spread of early farming in Europe. American Scientist 84:242-53.

Bragg, T.B., and A.A. Steuter. 1996. Pine Savanna ecology: The mixed Pine Savanna. In Pine Savanna Conservation: Preserving North America's Most Endangered

Christopherson, R.J., and R.I. Hudson. 1979. Seasonal energy expenditures and thermoregulatory responses of bison and cattle. Canadian Journal of Animal Science 59:611-17.

Christopherson, R.J., R.J. Hudson, and M.K. Christopherson. 1980. Effect of temperature on bison and cattle. Canadian Journal of Animal Science 60:558.

Collins, S.L., AK. Knapp, J.M. Briggs, J.M. Blair, and E.M. Steinauer. 1998. Modulation of diversity by grazing and mowing in native tallgrass Pine Savanna. Science 280:745-47. Comparative Ecology of Bison and Cattle

Diamond, J. 1997. Zebras, unhappy marriages, and the Anna Karenina principle: Why were most big wild mammal species never domesticated? In Guns, Germs and Steel: The Fates of Human Societies, 157175. New York: W.W. Norton and Company.

Ecosystem, ed. FB. Sampson and FL. Knopf, 53-66. Covelo, CA: Island Press. Christopherson, R.J., R.J. Hudson, and R.J. Richmond. 1976. Feed intake, metabolism, and thermal insulation of bison, yak, Scottish highland, and Hereford calves during winter. 55th Annual Feeder's Day Report. 55:51-2.

Epstein, H.E.; Lauenroth, W.K.; Burke, I.C.; Coffin, D.P. 1997. Productivity patterns of C3 and C4 functional types in the U.S. Great Plains. Ecology. 78: 722–731.

Fay, P.A. 1998. Insect diversity at the Tallgrass Pine Savanna and Niobrara Valley Preserves: Effects of fire and native and domestic grazers. Final Report of Research, submitted to The Nature Conservancy.

Griebel, R.L., S.L. Winter, and A.A. Steuter. 1998. Grassland birds and habitat structure in sandhills Pine Savanna managed using cattle or bison plus fire. Great Plains Research 8:255-68.

Hartnett, D.C., A.A. Steuter, and K.R. Hickman. 1997. Comparative ecology of native versus introduced ungulates. In Ecology and Conservation of Great Plains Vertebrates, ed. F. Knopf and F. Samson, 72-101. New York: Springer-Verlag.

Heitschmidt, R.K. and J.W. Stuth. 1991. Grazing management: An ecological perspective. Portland, OR: Timber Press

Kantrud, H.A. 1981. Grazing intensity effects on the breeding avifauna of North Dakota native grasslands. Canadian Field Naturalist 95:404-17.

Knapp, A.K., J.M. Blair, J.M. Briggs, S.L. Collins, D.C. Hartnett, L.C. Johnson, and E.G. Towne. 1999. The keystone role of bison in North American tallgrass Pine Savanna. Bioscience 49(1):39-50.

Knapp, A.K.; Briggs, J.M.; Koelliker, J.K. 2001. Frequency and extent of water limitation to primary production in a mesic grassland. Ecosystems. 4: 19–28.

Mack, R.N. and J.N. Thompson. 1982. Evolution in steppe with few large hooved mammals. American Naturalist 119:757-73.

McHugh, T. 1972. The Time of the Buffalo. Lincoln: University of Nebraska Press.

Meagher, M.M. 1978. Bison. In Big Game of North America, ed. J.L. Schmidt and D.L. Gilbert, 123-33. Harrisburg, PA: Stackpole Books.

Morgan, J. A.; LeCain, D. R.; Pendall, E.; [et al.]. 2011. C4 grasses prosper as carbon dioxide eliminates desiccation in warmed semi-arid grassland. Nature 476: 202-206.

Mueggler, W. F.; Stewart, W. L. 1978. Grassland and shrubland habitat types of western Montana. Gen. Tech. Rep. INT-66. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 154 p.

Peden, D.G., G.M. Van Dyne, R.W. Rice, and R.M. Hansen. 1974. The trophic ecology of *Bison bison L.* on shortgrass plains. Journal of Applied Ecology 11:489-98.

Peters, H.F. 1959. Feedlot study of bison and cattalo, and Hereford calves. Canadian Journal of Animal Science 38:87-90.

Pfeiffer, K.E. and A.A. Steuter. 1994. Preliminary response of sandhills Pine Savanna to fire and bison grazing. Journal of Range Management 47:395-97.

Plumb, G.E. and J.L. Dodd. 1993. Foraging ecology of bison and cattle on a mixed-grass Pine Savanna: Implications for natural area management. Ecological Applications 3: 631-43.

Rice, P. M., J. C. Toney, D. J. Bedunah, and C. E. Carlson. 1997. Plant community diversity and growth form responses to herbicide applications for control of *Centaurea maculosa*. Journal of Applied Ecology 34:1397– 1412.

Rice, R.M., R.E. Dean, and J.E. Ellis. 1974. Bison, cattle and sheep dietary quality and food intake. Proceedings of the Western Section. Society for Animal Science 25: 194-97. 342 Great Plains Research Vol. 9 No.2, 1999 Smoliak, S. and H.E Peters. 1955. Climatic effects on foraging performance of beef cows on winter range. Canadian Journal of Agricultural Science 35:213-16.

Sneft, R.L., L.R. Rittenhouse, and R.G. Woodmansee. 1985. Factors influencing selection of resting sites by cattle on shortgrass steppe. Journal of Range Management 38:295-99.

Sneft, R.L., M.B. Coughenour, W.W. Bailey, L.R. Rittenhouse, A.E. Sala, and D.M. Swift. 1987. Large herbivore foraging and ecological hierarchies. BioScience 37:789-99.

Stebbins, G.L. 1981. Coevolution of grasses and herbivores. Annals of the Missouri Botanical Garden 68:75-86.

Steuter, A.A. 1995. Biological management-grazing. In Tools for Intelligent Tinkering: A Steward's Handbook, ed. S. Green (Task Force), 3.1-3.13. Arlington, VA: The Nature Conservancy, A NatureServe Publication.

Steuter, A.A., B. Jasch, J. Ihnen, and L.L. Tieszen. 1990a. Wood1and/grassland boundary changes in the middle Niobrara Valley of Nebraska identified by delta carbon 13 values of soil organic matter. American Midland Naturalist 124:301-8.

Steuter, A.A., C.E. Grygiel, and M.E. Biondini. 1990b. A synthesis approach to research and management planning: the conceptual development and implementation. Natural Areas Journal 10:61-8.

Steuter, A.A., E.M. Steinauer, G.P. Hill, P.A. Bowers, and L.L. Tieszen. 1995. Distribution and diet of bison and pocket gophers in a sandhills Pine Savanna. Ecological Applications 5:756-66.

Stohlgren, T. J., D. Binkley, G. W. Chong, M. A. Klakhan, L. D. Schell, K. A. Bull, Y. Otsuki, G. Newman, M. Bashkin, and Y. Son. 1999. Exotic plant species invade hot spots of native plant diversity. Ecological Monographs 69:25–46.

Telfer, B.S. and J.P. Kelsall. 1984. Adaptation of some large North American mammals for survival in snow. Ecology 65:1828-34.

Telfer, E.S. and J.P. Kelsall. 1979. Studies of morphological parameters affecting ungulate locomotion in snow. Canadian Journal of Zoology 57:2153-59.

University of Nebraska-Lincoln, Gudmundsen Sandhills Laboratory. 1999. Annual Reports of Research. West Central Research and Extension Center, North Platte, NE.

Van Vuren, D. 1981. Comparative ecology of bison and cattle in the Henry Mountains, Utah. Proceedings of the Wildlife-Livestock Relationships Symposium, 449-57. Coeur d' Alene, Idaho.

Van Vuren, D. and M.P. Bray. 1983. Diets of bison and cattle on a seeded range in southern Utah. Journal of Range Management 36: 499-500.

Western Video Auction, Shasta Livestock, Cottonwood, CA. 1999. Sales representative telephone conversation with author, December 3.

Winslow, J.C.; Hunt, E.R.; Piper, S.C. 2003. The influence of seasonal water 1 availability on global C3 versus C4 grassland biomass and its implications for climate change research. Ecological Modelling. 163: 153–173.

Sagebrush

Baker, W.L, 2006. Fire and restoration of sagebrush ecosystems. Wildlife Society Bulletin 34:177-185.

Beck, Jeffry L. and Dean L. Mitchell. 2000. Influences of livestock grazing on sage grouse habitat. Wildlife Society Bulletin 2000, 28(4):993-1002.

Cooper, S.V., P. Lesica, and G.M. Kudray. 2007 Post-fire Recovery of Wyoming Big Sagebrush-steppe in Central and Southeast Montana. Prepared for BLM. 34 pp.

Swanson, C.C., M.A. Rumble, T.W. Grovenburg, N.W. Kaczor, R.W. Klaver, K.M. Herman-Brunson, J.A. Jenks, and K.C Jensen. 2013. Greater Sage-Grouse Winter Habitat Use on the Eastern Edge of Their Range. The Journal of Wildlife Management 77(3): 486-494. 9 pp.

Tilley D.J, D. Ogle, L. St. John, B. Benson. 2006. Big Sagebrush Plant Guide. USDA NRCS. 12 pp.

U.S. Fish and Wildlife Service. 2013. Greater Sage-grouse (*Centrocercus urophasianus*) Conservation Objectives: Final Report. U.S. Fish and Wildlife Service, Denver, CO. February 2013.

Juniper

FEIS – Fire Effects Information System online database. 2016. Fire Ecology of Rocky Mountain Juniper.

Gruell, G. E. 1983. Fire and vegetative trends in the Northern Rockies: interpretations from 1871-1982 photographs. USDA Forest Service General Technical Report INT 158, Ogden, UT.

Gruell, G. E., S. Bunting and L. Neuenschwander. 1985. Influence of fire on curl-leaf mountain mahogany in the Intermountain West. Pages 58-72 in J. K. Brown and J. Lotan (eds.), Fire's effects on wildlife habitat. U. S. Forest Service General Technical Report INT-186.

Paysen, Timothy E.; Ansley, R. James; Brown, James K.; [and others]. 2000. Fire in western shrubland, woodland, and grassland ecosystems. In: Brown, James K.; Smith, Jane Kapler, eds. Wildland fire in ecosystems: Effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-volume 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 121-159. [36978]

Green Ash

Girard, M.M. 1985. Native Woodland Ecology and Habitat Type Classification of Southwestern North Dakota. Thesis.

Girard, M.M., H. Goetz, and A.J. Bjugstad. 1987. Factors influencing woodlands of southwestern North Dakota. Pine Savanna Naturalist 19: 189-198.

Hansen, P.L., R.D. Pfister, K. Boggs, B.J. Cook, J. Joy, and D.K. Hinckley. 1995. Classification and Management of Montana’s Riparian and Wetland Sites.

Lesica, P. 2001. Recruitment of Fraxinus pennsylvanica in eastern Montana woodlands. Madrono 48: 286-292.

Lesica, P. 2009. Can regeneration of green ash (*Fraxinus pennsylvanica*) be restored in declining woodlands in eastern Montana? Rangeland Ecology and Management 62: 564-571.

Lesica, P. and C. Marlow, 2013. Green Ash Woodlands. A Review. 20 pp.

Noble, D. L. and R.P. Winokur (eds.). 1984. Wooded draws: characteristics and values for the Northern Great Plains. South Dakota School of Mines and Technology, Rapid City.

Uresk, D. W. and C. E. Boldt. 1986. Effects of cultural treatments on regeneration of native woodlands on the northern High Plains. Pine Savanna Naturalist 18: 193-202.

Uresk, D. W., J. Javersak and D. E. Mergen. 2009. Tree sapling and shrub heights after 25 years of livestock grazing in green ash draws in western North Dakota. Proceedings of the South Dakota Academy of Science 88: 99-108.

Aspen and Cottonwood

Aspen

Barnes, B.V. 1966. The clonal growth habit of American aspens. Ecology 47: 439-447.

Bartos, D.L., W.F. Mueggler, and R.B. Campbell, Jr. 1991. Regeneration of aspen by suckering on burned sites in western Wyoming. USDA Forest Service Research Paper INT-448.

Brown, J.K. and N.V. DeByle. 1989. Effects of prescribed fire on biomass and plant succession in western aspen. USDA Forest Service Research Paper INT-412.

Campbell, R.B. Jr. and D.L. Bartos 2001. Aspen Ecosystems: Objectives for Sustaining Biodiversity. USDA Forest Service Proceedings RMRS-P-18. 12 pp.

Hoff, C. 1957. A comparison of soil, climate, and biota of conifer and aspen communities in the Central Rocky Mountains. Am. Midl. Nat. 58: 115-140.

Jelinkski, D.E. and W.M. Cheliak. 1992. Genetic diversity and spatial subdivision of Populus tremuloides (Salicaceae) in a heterogeneous landscape. American Journal of Botany 79: 728-736.

McDonough, W.T. 1985. Sexual reproduction, seeds, and seedlings. Pages 25-28 in N.V. DeByle and R.P. Winokur, editors. Aspen: ecology and management in the western United States. USDA Forest Service General Technical Report RM-119.

Reed, R.M. 1971. Aspen forests of the Wind River Mountains, Wyoming. American Midland Naturalist 86: 327-343.

Romme, W.H., L. Bohland, C. Persichetty, and T. Caruso. 1995. Germination ecology of some common forest herbs in Yellowstone National Park, Wyoming, U.S.A. Arctic and Alpine Research 27: 407-412.

Romme, W.H., M.G. Turner, R.H. Gardner, W.W. Hargrove, G.A. Tuskan, D.G. Despain and R.A. Renkin. 1997. A rare episode of sexual reproduction in aspen (*Populus tremuloides Michx.)* following the 1988 Yellowstone fires. Natural Areas Journal 17: 17-25.

Cottonwood

Adams, D.E. R.C. Anderson, and S.L. Collins. 1982. Differential response of woody and herbaceous species to summer and winter burning in an Oklahoma grassland. The Southwestern Naturalist. 27:55-61.

Auble, G.T. and M.L. Scott. 1998. Fluvial disturbance patches and cottonwood recruitment along the upper Missouri River, Montana. Wetlands 18:546-556.

Fire Effects Information System (FEIS) Database. Accessed 2016. http://www.fs.fed.us/database/feis/plants/tree/

Lesica, P. and S. Miles. 1999. Russian olive invasion into cottonwood forests along a regulated river in north-central Montana. Canadian Journal of Botany 77:1077-1083.

Lesica, P. and S. Miles. 2004. Beavers indirectly enhance the growth of Russian olive and tamarisk along eastern Montana rivers. Western North American Naturalist 64:93-100.

Lytle, D.A. and D.M. Merritt. 2004. Hydrologic regimes and riparian forests: a structure population model for cottonwood. Ecology 85:2493-2503.

Rood, S.B., and J.M. Mahoney. 1990. Collapse of riparian poplar forests downstream from dams in western Pine Savannas; probable causes and prospects for mitigation. Environmental Management 14:451-464.

Scott M.L., T. Auble, and J.M. Friedman. 1997. Dependency of cottonwood establishment along the Missouri River, Montana, USA. Ecological Applications, 7(2), 1997, pp. 677–690.

Alpine

Bamberg, S.A. 1961. Ecology of the vegetation and soils associated with calcareous parent materials in three alpine regions of Montana. Ecological Monographs, 1968.

Bamberg, S.A. and Major, J. 1968. Ecology of the vegetation and soils associated with calcareous parent materials in three alpine regions of Montana. Ecological Monographs 38: 127-167.

Choate, C.M. and J.R. Habeck. 1967. Alpine plant communities at Logan Pass, Glacier National Park, Montana. Proceedings of the Montana Academy of Sciences. 27:36-54.

Cooper , S.V., P. Lesica, D. Page-Dumroese. 1997. Plant community classification for alpine vegetation on the Beaverhead National Forest, Montana. Gen. Tech. Rep. INT-GTR-362. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Johnson, P.L. and W.D. Billings. 1962. The alpine vegetation of the Beartooth plateau in relation to cryopedogenic processes and patterns. Ecological Monographs, 32: 105-135.

Knight, D.H. 1994. Mountains and Plains: The ecology of Wyoming landscapes. Yale University Press, New Haven, Connecticut.

Lesica, P. 1993 Vegetation and flora of the Line Creek Plateau Area, Carbon County, Montana. Unpublished report to US Forest Service, Montana Natural Heritage Program, Helena, MT. 30 pp.

Lesica, P. 2012. Proceedings Seventh Montana Plant Conservation Conference. February 15 and 16, 2012

Potkin, M and L. Munn. 1987. Subalpine and alpine plant communities in the Bridger Wilderness, Wind River Range, Wyoming. Unpublished report to the Bridger-Teton National Forest, University of Wyoming Department of Plant, Soil and Insect Sciences, Laramie.

Potkin, M. and L. Munn. 1987. Subalpine and alpine plant communities in the Bridger Wilderness, Wind River Range, Wyoming. Unpublished report to the Bridger-Teton National Forest, University of Wyoming Department of Plant, Soil and Insect

Sciences, Laramie. Bliss, L.C. 1956. A comparison of plant development in microenvironments of arctic and alpine tundras. Ecological Monographs 26(4): 303-337.

Wells, A, J.L. Boettinger, K.E. Houston, D.W. Roberts. 2015 Ecological Types of the Eastern Slope of the Wind River Range, Shoshone National Forest, Wyoming. 431 pp.

Wells, A. 1998. Custer National Forest National Cooperative Soil Survey and Terrestrial Ecological Unit Inventory: Pre-Mapping, Preliminary Data Analysis, and Study Design Development. Unpublished document.

Williams, K.L. 2012 Classification of the grasslands, shrublands, woodlands, forests, and alpine vegetation associations of the Custer National Forest portion of the Beartooth Mountains in southcentral Montana. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Biological Sciences. Montana State University, Bozeman, Montana.

Plant Materials

Cochrane, J.R. and P. Delphey. 2002. Status assessment and conservation guidelines, Dakota skipper. U.S. Fish and Wildlife Service, Twin Cities Field Office.

Fire Effects Information System. 2016. Online database; accessed May 31, 2016. http://www.fs.fed.us/database/feis/plants/forb/echang/all.html

Kindscher, K., D.M. Price, and L. Castle. 2008. Resprouting of *Echinacea angustifolia* Augments Sustainability of Wild Medicinal Plant Populations. Econ Bot 62 no2 Jl.

Nabokov, P. and L. Loendorf. 1994. Every Morning of the World. Ethnographic Resources Study. Bighorn Canyon National Recreation Area: Including information on adjacent lands managed by Custer National Forest and the Bureau of Land Management.

Natureserve. 2016. NatureServe Web Service. Arlington, VA. U.S.A. Available http://services.natureserve.org (Accessed: May 31, 2016)

Price, D.M. and K. Kindscher. 2007. One Hundred Years of *Echinacea angustifolia* Harvest in the Smoky Hills of Kansas, USA. Economic Botany, 61(1), 2007, pp. 86–95. © 2007, by The New York Botanical Garden Press, Bronx, NY 10458-5126 U.S.A.

Price, N., Elkshoulder, G., Sr., J. Red Cloud, E. Red Cloud; M. Two Moons, F. Limpy, T. Rock Roads, Sr., and R. Brien. 1996. Poker Jim / Montco Traditional Plant Study. A Confidential Report.

Royer, R.A. and G.M. Marrone. 1992. Conservation status of the Dakota skipper (Hesperia dacotae) in North and South Dakota. Report to U.S.D.I., Fish and Wildlife Service, Denver, CO.

Tallbull, W. Plant Lore of the Northern Cheyenne Tribe. A Continuing Teaching Materials as Part of Cheyenne Oral Traditions by William "Bill" Tallbull.

United States Fish and Wildlife Service. 2014. Dakota Skipper Fact Sheet. October 2014.

Appendix A – Non-Forest Life Forms and Cover Types (VMap)

One broad depiction of vegetation types is categorizing vegetation as forested or non-forested. In the montane unit, forested vegetation (conifers) occupies 61 percent of the landscape, transitional forest (recently burned forested vegetation) occupies 7 percent, and non-forest vegetation occupies 16 percent. In the pine savanna unit, forested vegetation (conifers) occupies 29 percent of the landscape, transitional forest (recently burned forested vegetation) occupies 14 percent, and non-forest vegetation occupies 56 percent (VMap). See Table . The potential for forested conditions are estimated to be higher than existing forested cover types which is due to recent (about the last 20 years) large-scale wildfires shifting existing vegetation.

Table A-1. National Forest System acres and proportion of forested, non-forested, and transitional forested vegetation (VMap)

Landscape Area	Forested (Conifer)	Non-Forested	Non-forested - Transitional Forest (burned)	Unit NFS Ac
Montane				
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	1308022	335909	171105	2157246
Bridger, Bangtail, Crazy	142921	25694	2385	205008
Pryor	41785	29686	2936	75067
Montane Subtotal	1492729	391289	176426	2437321
%	61%	16%	7%	85%
Pine Savanna				
Ashland	140462	215350	76439	436124
Sioux	32635	121810	5792	163982
Pine Savanna Subtotal	173097	337160	82231	600106
%	29%	56%	14%	99%
Grand Total	1665826	728449	258657	3037427
%	55%	24%	9%	87%

Another broad depiction of existing vegetation is lifeform. Lifeform is based on the type of dominant vegetation from the following broad categories: grass, shrub, tree, transitional forest, and other. In the montane unit, tree life forms (conifer and broadleaf) occupies 62 percent of the landscape, transitional forest (recently burned forested vegetation) occupies 7 percent, shrub life form occupies 2 percent, and grass life form occupies 13 percent. In the Pine Savanna unit, tree life forms (conifer and broadleaf) occupies 31 percent of the landscape, transitional forest (recently burned forested vegetation) occupies 14 percent, shrub life form occupies 3 percent and grass life form occupies 51 percent (VMap). See Table A-2.

Table A-2. Proportion of life forms by landscape area, VMap 2015 (National Forest System lands)

Landscape Area	Grass	Shrub	Tree	Transitional Forest (burned)	Other[22]
Montane Units					
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	13%	2%	61%	8%	16%
Bridger, Bangtail, Crazy Mtns	11%	1%	70%	1%	17%
Pryor Mtns	32%	2%	61%	4%	1%
Montane Subtotal	13%	2%	62%	7%	16%
Pine Savanna Units					
Ashland	45%	3%	33%	18%	1%
Sioux	65%	3%	26%	4%	2%
Pine Savanna Subtotal	51%	3%	31%	14%	1%

Table , Table and Table summarize amounts of non-forested grassland / shrublands by dominance groups

Table A-3. National Forest System acreage of grasslands and shrublands by landscape area, VMap 2015

Landscape Area	Dry Grass	Wet Grass	Dry Shrub	Mesic Shrub
Montane Units				
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	254891	25263	31226	11645
Bridger, Bangtail, Crazy Mtns	21669	1287	904	609
Pryor Mtns	23881	108	765	551
Montane Subtotal	300441	26658	32895	12805
Pine Savanna Units				
Ashland	196627	1058	10038	5274
Sioux	104695	968	842	4750
Pine Savanna Subtotal	301322	2026	10880	10024

Table A-4. National Forest System acreage of deciduous broadleaf woodlands by landscape area, VMap 2015

Landscape Area	Green Ash	Cottonwood	Aspen
Montane Units			
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns		379	11015
Bridger, Bangtail, Crazy Mtns		7	1184
Pryor Mtns			108
Montane Subtotal	0	386	12307
Pine Savanna Units			
Ashland	1378		976
Sioux	10046	421	88
Pine Savanna Subtotal	11424	421	1064

[22] Other includes water, urban, and sparse vegetation such as rock, scree, and badlands.

Table A-5. National Forest System acreage of juniper and limber pine woodlands by landscape area, VMap 2015

Landscape Area	Juniper	Limber Pine
Montane Units		
Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns	1492	35
Bridger, Bangtail, Crazy Mtns	32	288
Pryor Mtns	4273	Present
Montane Subtotal	5797	423
Pine Savanna Units		
Ashland	Present	
Sioux	Present	
Pine Savanna Subtotal	Present	

Table , Table , Table ,

Table , and Table display cover type acreages by landscape area and by ownership.

Table A-6. Madison, Henry's, Gallatin, Absaroka and Beartooth Mountains landscape area life forms and cover type acreage by ownership within proclaimed boundary, VMap 2015

Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns Life Forms	% Life Forms (NFS)	Cover Type	Non-NFS	NFS Lands	Grand Total
Grass	13%	Grass - Dry	26830	254891	281721
		Grass - Wet	1518	5502	7019
		Grass/Sedge- Riparian	2604	19761	22364
Subtotal				280154	
Shrub	2%	Shrub - Xeric	11994	31226	43220
		Shrub - Mesic - Riparian	520	1890	2409
		Shrub - Mesic	987	9755	10743
Subtotal				42871	
Tree	61%	Cottonwood	658	379	1036
		Aspen - Riparian	2545	7634	10180
		Aspen	1392	3381	4773
		Juniper	207	783	989
		Juniper-Imix	120	708	828
		Limber Pine-Imix	9	35	44
		Ponderosa Pine	92	333	425
		Ponderosa Pine-IMix	38	208	246
		Douglas Fir	45502	283185	328687
		Douglas Fir-IMix	8986	60990	69976
		Douglas Fir-TMix	6	253	260
		Lodgepole Pine	15948	303721	319669
		Lodgepole Pine-IMix	9229	114787	124016
		Lodgepole Pine-TMix	502	6355	6857
		Engelmann Spruce	3579	35679	39258
		Engelmann Spruce-Imix	1289	8206	9495
		Engelmann Spruce-TMix	3627	42540	46168
		Subalpine Fir	2245	79518	81763
		Subalpine Fir-IMix	402	6010	6412
		Subalpine Fir-Tmix	2427	44065	46492
		Whitebark Pine	3668	215932	219600
		Whitebark Pine-Imix	1510	52285	53795
		Whitebark Pine-Tmix	67	2011	2077
		Imix	2431	34579	37010
		Tmix	990	17330	18320
Subtotal				1320907	
Transitional Forest	8%	Transitional Forest (burned Forest)	9099	171105	180203

Madison, Henry's, Gallatin, Absaroka and Beartooth Mtns Life Forms	% Life Forms (NFS)	Cover Type	Non-NFS	NFS Lands	Grand Total
Other	16%	Sparse Vegetation	5899	319021	324920
		Urban	5655	543	6198
		Water	8936	22646	31582
Grand Total			181511	2157246	2338757

Table A-7. Bridger, Bangtail, and Crazy Mountains life forms and cover type acreage by ownership within proclaimed boundary, VMap 2015

Bridger, Bangtail, Crazy Mtns Life Forms	% Life Form (NFS)	Cover Type	Non-NFS	NFS Lands	Grand Total
Grass	11%	Grass - Dry	23393	21669	45062
		Grass - Wet	107	491	598
		Grass/Sedge - Riparian	518	798	1316
Subtotal				22958	
Shrub	1%	Shrub - Xeric	1460	904	2364
		Shrub - Mesic	211	260	471
		Shrub - Riparian	304	349	652
Subtotal				1513	
Tree	70%	Cottonwood	27	0	27
		Cottonwood - Riparian	10	7	17
		Aspen	295	140	435
		Aspen - Riparian	993	1044	2037
		Juniper	20	11	31
		Juniper-Imix	34	21	54
		Limber Pine	1	5	6
		Limber Pine-Imix	127	283	410
		Douglas Fir	52376	74843	127219
		Douglas Fir-Imix	3529	11001	14530
		Douglas Fir-Tmix	1	15	16
		Lodgepole Pine	4250	19938	24188
		Lodgepole Pine-Imix	2641	13173	15814
		Lodgepole Pine-Tmix	51	336	387
		Engelmann Spruce	474	1154	1628
		Engelmann Spruce-Imix	164	775	939
		Engelmann Spruce-TMix	302	1130	1432
		Subalpine Fir	1505	6766	8271
		Subalpine Fir-Imix	394	1624	2018
		Subalpine Fir-Tmix	1517	5489	7006
		Whitebark Pine	726	1536	2262
		Whitebark Pine-Imix	498	1575	2073
		Whitebark Pine-Tmix		2	2
		IMix	706	2863	3569
		TMix	64	413	477
Subtotal				144144	
Transitional Forest	1%	Transitional Forest (burned Forest)	1092	2385	3477
Other	17%	Urban	55	1	56
		Sparse Vegetation	11417	33605	45022
		Water	310	402	712
Grand Total			109571	205008	314579

Table A-8. Pryor Mountains life forms and cover type acreage by ownership within proclaimed boundary, VMap 2015

Pryor Life Forms	% Life Forms (NFS)	Cover Type	Non-NFS	NFS Lands	Grand Total
Grass	32%	Grass - Dry	983	23881	24864
		Grass - Wet	61	95	156
		Grass/Sedge - Riparian	20	13	32
Subtotal				23989	
Shrub	2%	Shrub - Xeric	30	765	795
		Shrub - Mesic	266	431	697
		Shrub - Riparian	122	120	243
Subtotal				1316	
Tree	61%	Aspen	5	21	27
		Aspen - Riparian	28	87	115
		Juniper	411	3739	4150
		Juniper-IMix	13	534	547
		Ponderosa Pine	67	320	387
		Ponderosa Pine-Imix	22	469	491
		Ponderosa Pine-Tmix		4	4
		Douglas Fir	513	16151	16664
		Douglas Fir-Imix	109	4005	4114
		Lodgepole Pine	20	12964	12984
		Lodgepole Pine-Imix	27	4881	4908
		Lodgepole Pine-Tmix		76	76
		Englemann Spruce		407	407
		Englemann Spruce-IMIX		233	233
		Englemann Spruce-TMIX		450	450
		Subalpine Fir		165	165
		Subalpine Fir-Imix		31	31
		Subalpine Fir-Tmix		154	154
		IMix	34	1226	1260
		TMix		249	249
Subtotal				46166	
	4%	Transitional Forest (burned Forest)		2936	2936
Other	1%	Urban	3		3
		Sparse Vegetation	143	657	800
		Water	1	1	2
Grand Total			2877	75067	77944

Table A-9. Ashland Ranger District life forms and cover type acreage by ownership within proclaimed boundary, VMap 2015

Ashland Life Forms	% Life Forms (NFS)	Cover Types	Non-NFS	NFS Lands	Grand Total
Grass	45%	Grass - Dry	34444	196627	231071
		Grass - Wet	8912	1013	9925
		Grass/Sedge - Riparian	44	45	89
Subtotal				197685	
Shrub	3%	Shrub – Mesic -Riparian	240	83	322
		Shrub - Mesic	2703	5191	7894
		Shrub - Xeric	984	10038	11022
Subtotal				15312	
Tree	33%	Cottonwood	553	974	1527
		Aspen		2	2
		Aspen - Riparian	2	0	2
		Green Ash Woodland	561	562	1123
		Green Ash Woodland - Riparian	1649	816	2465
		Ponderosa Pine	8655	140462	149118
Subtotal				142816	
Transitional Forest	18%	Transitional Forest (burned Forest)	5466	76439	81905
Other	1%	Urban	431	86	517
		Sparse Vegetation	598	3691	4289
		Water	98	96	194
Grand Total			65342	436124	501466

Table A-10. Sioux Ranger District life forms and cover type acreage by ownership within proclaimed boundary, VMap 2015

Sioux Life Forms	% Life Form (NFS)	Cover Type	Non-NFS	NFS Lands	Grand Total
Grass	65%	Grass- Dry	8443	104695	113138
		Grass - Wet	702	505	1207
		Grass/Sedge - Riparian	103	463	567
Subtotal				105663	
Shrub	3%	Shrub - Xeric	19	842	861
		Shrub - Mesic	397	4693	5091
		Shrub - Riparian	5	57	62
Subtotal				5592	
Tree	26%	Cottonwood	59	421	479
		Aspen	10	55	65
		Aspen - Riparian		33	33
		Green Ash Woodland	353	9240	9593
		Green Ash Woodland - Riparian	120	806	925
		Ponderosa Pine	1766	32635	34401
Subtotal				43190	

Sioux Life Forms	% Life Form (NFS)	Cover Type	Non-NFS	NFS Lands	Grand Total
Transitional Forest	4%	Transitional Forest (burned Forest)	223	5792	6015
Other	2%	Urban	18	10	28
		Sparse Vegetation	123	3605	3727
		Water	14	130	144
Grand Total			12354	163982	176336